The Welding Engineer

...INEER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

...ume XXV February, 1940 Number 2

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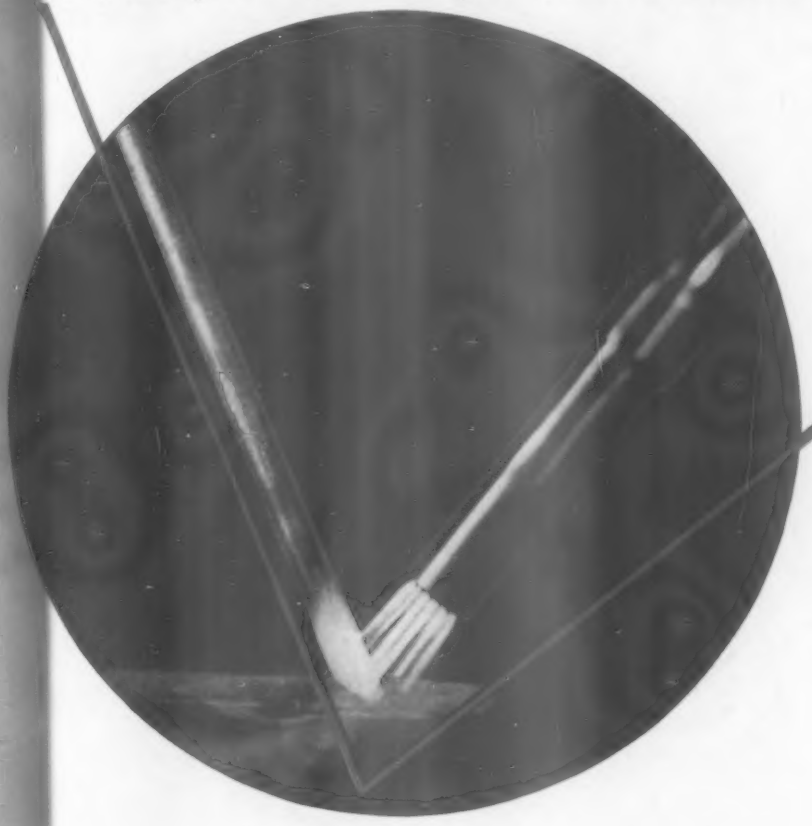

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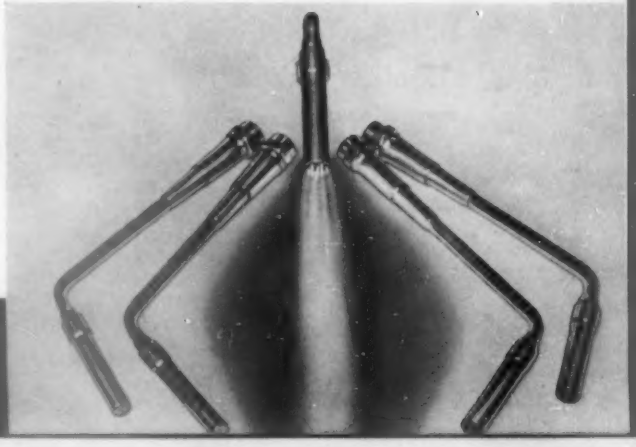

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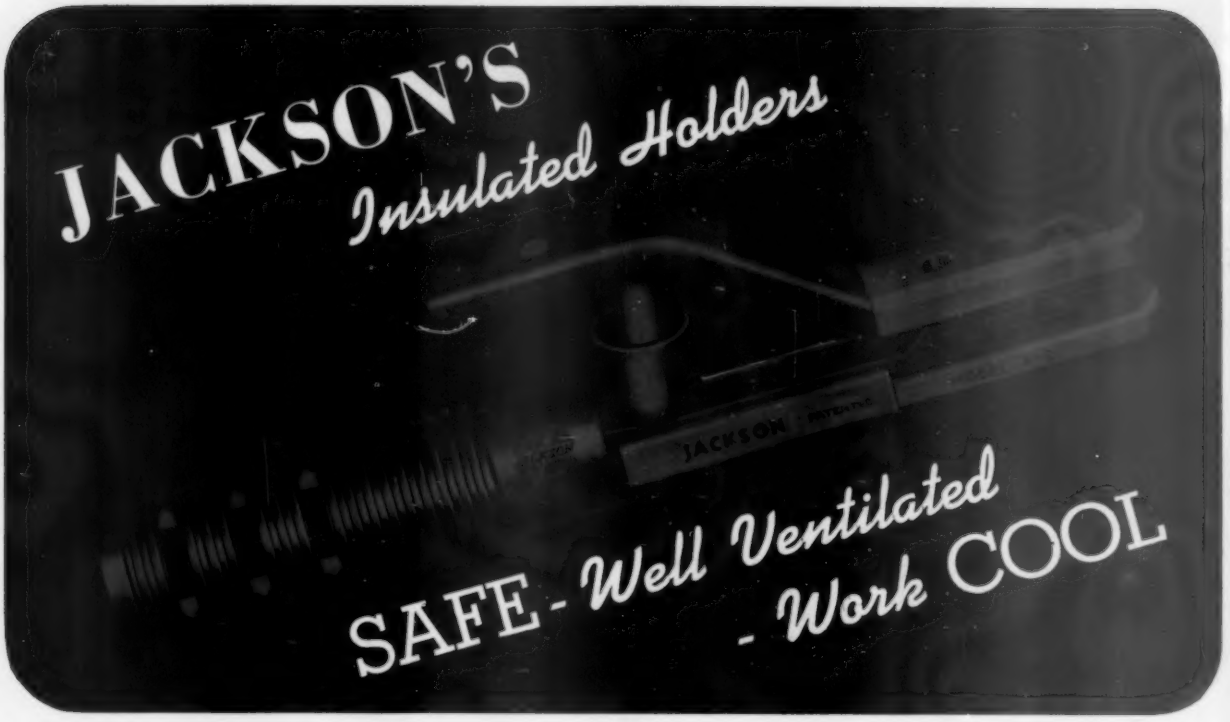

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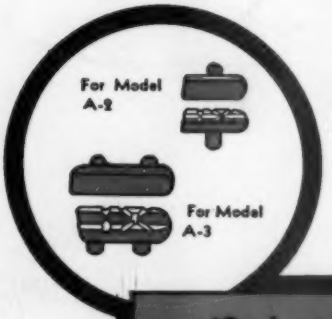

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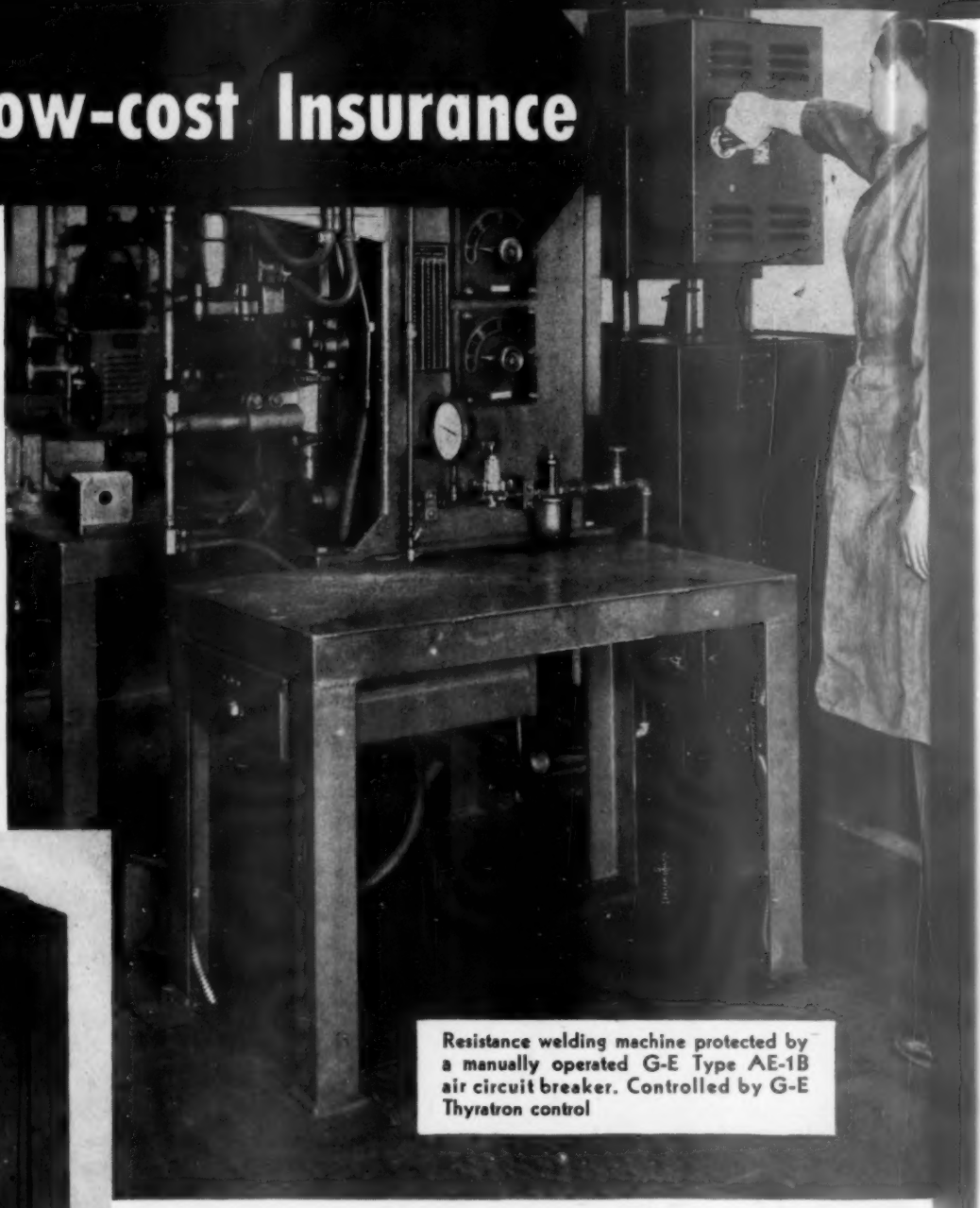

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Road Building Equipment

WE HAD AN opportunity to visit the equipment exhibits of the American Road Builders Association just a few days ago. It was evident to us that welding is far from a stranger in this industry. There is abundant evidence that pioneering spirits have pointed the way. Equipment designers in this husky industry have complete confidence in welding. In fact, walking around the exhibit hall, we became quite convinced that designers now have more confidence in welding than they have in riveted construction. The manufacturers who still stick to riveted and cast construction, are definitely in the minority. We imagine that their salesmen have to offer some pretty strong alibis for their lack of welded construction. The contractors who purchase this equipment are definitely cost-minded and equipment seems to be sold on its ability to deliver the goods at a lower cost. Consequently, weight reduction is highly important. Stamina in service is equally important. Both are achieved by means of welding.

Welding seems to forge ahead fastest in those fields where the good old American pioneering spirit has freedom to exert itself. The pioneer blazes the trail. The more timid souls follow him down the trail. We need more of these daring pioneers in every industry now using welding.

Plasticity of Metals

ONE OF THE properties prized most highly in metals and their alloys, is that property which we prefer to call plasticity. In the tensile test it is measured by per cent elongation and also by per cent reduction in area. In fact, measurements of hardness are made by determining resistance to plastic flow. The experts term hardness as resistance to penetration, but we feel that this is just another way of saying resistance to plastic flow. Any man who has welded knows that welding would be extremely difficult and not very far along today were it not for this highly desirable physical property, characteristic of most metals. Not only would welding be restricted, but practically all metal-forming operations and deep drawing would be impossible, without plasticity.

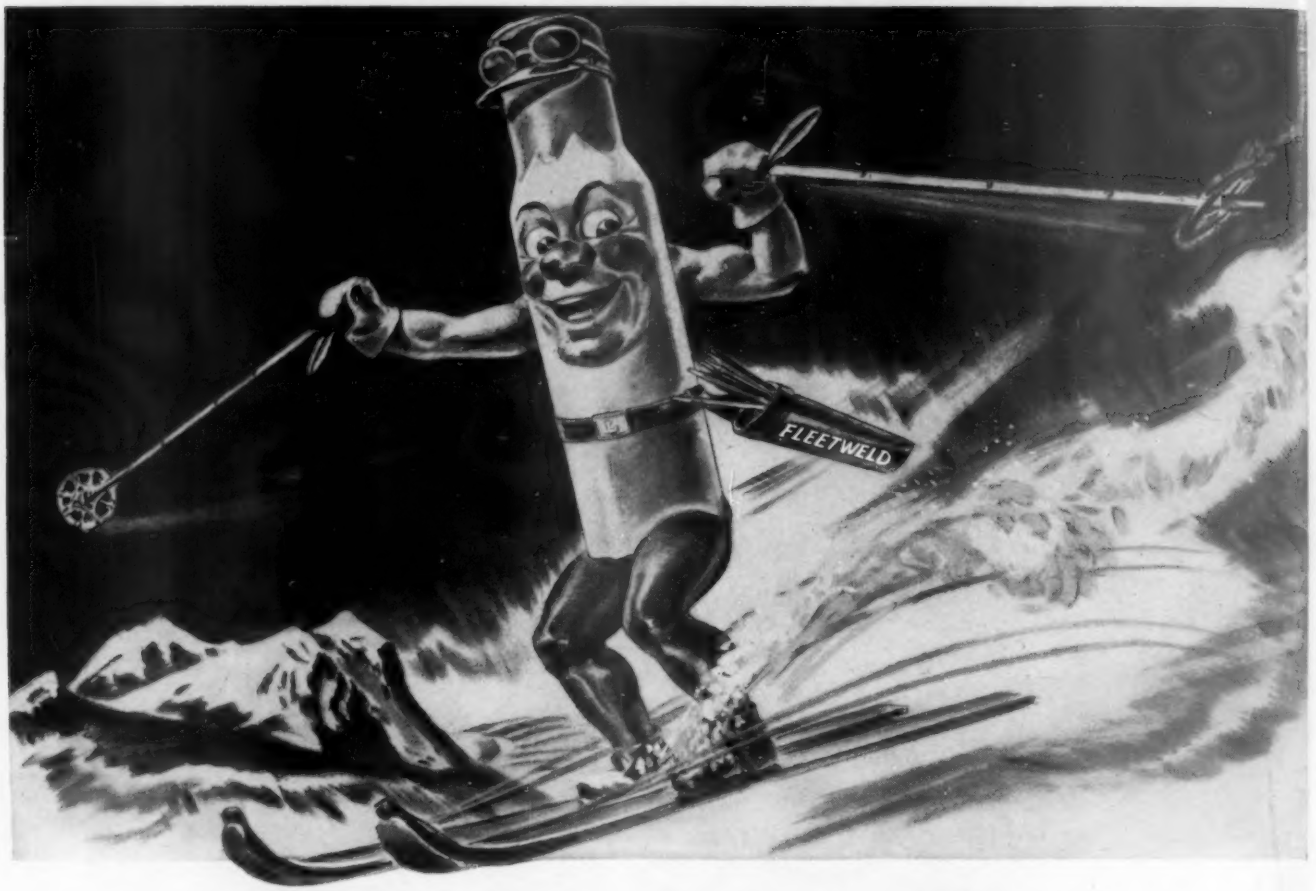
What is it that makes a steel "tough?" A steel must possess ability to flow plastically in regions of high stress concentration in order to qualify as a "tough" steel. As we look at it, the notch impact test is really a measure of "plastic viscosity" in the solid state (if we may be excused for coining a new metallurgical term).

The problems of welding cast-iron are well known. As pointed out in the article on this subject, published elsewhere in this issue, the absence of plasticity at room temperature makes cast-iron welding quite a tricky problem. From the standpoint of plasticty, cast-iron is one of the most difficult materials anyone can be called upon to weld. It is the classic example of zero toughness as measured by the impact test. No doubt the early fears concerning locked-up stresses must have originated among welders of cast-iron. Shrinkage stresses have a most disagreeable way of cracking cast-iron welds.

This reminds us of a young apprentice in a railroad shop who had been reading considerably of the evil spirits of welding witchcraft, dubbed by various names, but commonly classified as "residual stresses." He worried himself sick about it. One day he went into the G.S.M.P., and made the preposterous suggestion that henceforth all locomotive tires should be stress-relieved. He told them that welding engineers had resurrected this old demon of witchcraft days and he felt it was about time that the big boss started to worry about these terrible stresses. Did the G.S.M.P. start worrying? Hardly.

This grizzled veteran of the iron horse industry only sat back and laughed. He told the young apprentice to go back to the round house and quite worrying about the tires on the big driving wheels. He knew from his long years of experience in railroading that tires, somehow or other, like to hug the driving wheels, and they like to feel the thrill of internal stresses in their sinewy fibers. "In fact, to keep the locomotives running," he added, "we must keep on stressing these temperamental tires. They love it." The railroad safety record proves quite definitely that steel tires can be stressed without danger. Why should anyone become scared?

These tires are made of "tough" steel. They possess that highly desirable quality of Plasticity. Long live Plasticity! May he never grow old and bewhiskered or develop hardening of the arteries and bone embrittlement. May he stay youthful forever!



SKIS are in the Headlines

"The fleetfooted ski patrols we're hearing about remind me of my smooth gliding for welding folks these days. Those Finns are whizzes, but here's how I go them one better:

"I can have the slope for my operations varied to suit the foray at hand. When I encounter a job that requires *high speed*, I get a *steep-slope*. When I want to *dig in*, I get a *gradual slope*. I get this cooperation from a *"Shield-Arc"*—the Welder with the Job Selector. It can be set to give any desired slope of volt-ampere curve, providing any TYPE of welding arc to suit the job. *"Shield-Arc's"* Current Control varies the arc INTENSITY. Job Selector and Current Control are each *self-indicating* and provide *continuous selection* for *accurate* results every time.

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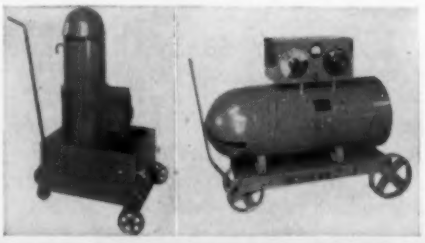

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Fig. 1—Oil storage tank under construction. This tank will have a Wiggins breather roof. Photo (Chicago Bridge & Iron Co.).

Field welding procedure for

Storage Tanks and Vessels

★ Typical details of joints used in tank construction—Direction of electrode travel in welding vertical joints—Sequence of welding to minimize shrinkage stresses—Procedure in welding pressure tanks

THE CONVENTIONAL oil storage tank is a vertical cylinder with a flat bottom and nearly flat roof. It is too large for shipment as a unit and therefore must be field erected. There is practically no pressure acting on the oil surface in the tank. The roof and bottom resist no calculated stresses due to liquid pressure; the side sheets are designed to withstand the entire bursting force of the liquid, and the intensity and direction of the stress are readily determined. Welding for oil storage tanks is finding increased acceptance because it provides joints which are initially leak-proof and remain so in service.

Recognizing the importance of proper design, the American Petroleum Institute (A.P.I.) and the American Welding Society (A.W.S.) have cooperated in preparing A.P.I. Standards No. 12-C, covering rather completely the important design features of welded oil storage tanks. These specifications are useful both to the designer and the fabricator. They require that the plates conform to ASTM-A7 or ASTM-A10 specifications and that the structural steel be of ASTM-A7 material.

Joint Details

In Fig. 3 and Fig. 4 we show welded joint details which are standards of the Chicago Bridge & Iron Co. for oil storage tanks. Alternative details are recommended in A.P.I. Standards No. 12-C, which state that a manufacturer may use welding grooves other than those recommended, provided he qualifies them under the A.W.S. "Standard Qualification Procedure."

Figure 3 shows typical details for oil storage tanks with completely butt-welded shells; Fig. 4 shows typical details for tanks having shells butt-welded, where the plates are more than

Fig. 2—Welded water storage tank of 1,500,000 gal. capacity. Photograph was taken before final coat of paint was applied. Photo (Chicago Bridge & Iron Co.).

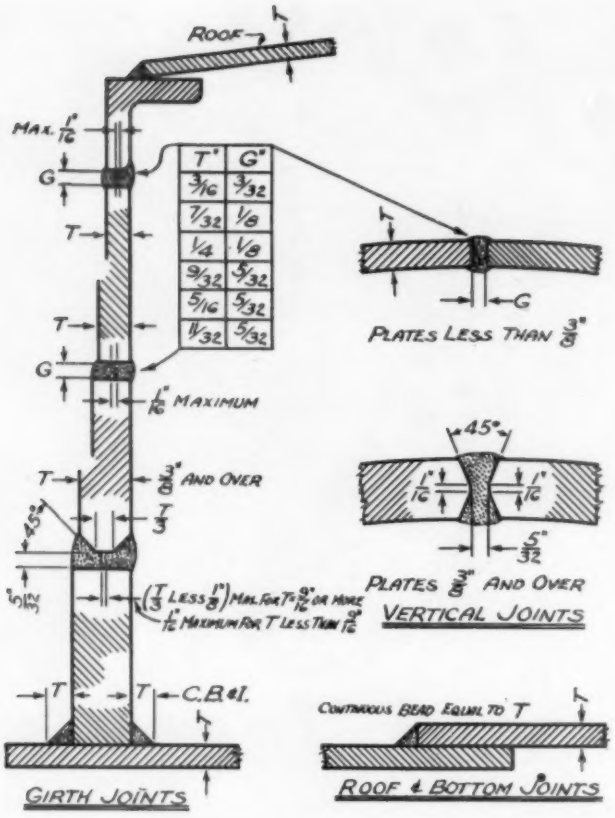


Fig. 3—Welding details for cylindrical storage tanks with butt-welded shells. Drawing (Chicago Bridge & Iron Co.).

3/8 in. thick, and lap-welded where they are 3/8 in. and less in thickness. The vertical butt joints are shown to indicate fusion throughout the entire plate thickness; the girth butt joints are shown to indicate fusion through only part of the plate thickness. Unquestionably the vertical joints should be completely fused since they withstand the entire bursting force of the liquid. Engineers are not in complete accord as to the girth joints, but it is logical that they be welded only sufficiently to provide for corrosion, to hold the adjacent plate edges in line, to prevent leakage, and to provide a small reserve of strength to withstand stresses induced by uneven settlement of the foundations, by wind, and by temperature variations.

In lap-welded construction it has been customary to fully weld both edges of vertical joints, only if the stress requires full welding, and to continuously weld girth joints on the outside edge only and intermittently weld the inside edge. However, the present trend is towards the elimination of intermittent lap welds. They are definitely "on the way out."

Under A.P.I. Standards No. 12-C butt-welded joints are allowed an efficiency of 85% and fully welded lap joints, an efficiency of 70%. These efficiencies are applied to 21,000 lb. per sq. in. as a base.

Field Welding Procedure

There is as yet no fixed rule governing the direction of travel of the electrode in welding vertical joints. In general, however, square-butted vertical joints, and 3/16 in. and 1/4 in. vertical lap joints are welded with the electrode moving downward; and vertical double and single V and U joints are welded with a downward travel of the electrode for the first and outermost passes, and with an upward travel for all other passes. The small initial downward pass layer forms a bridge across the gap between the abutting edges upon which subsequent thicker upward pass layers are built. The outer thin downward pass layers give the weld a good external appearance, and, to the same extent, refine the interior layers on which they are deposited.

This general procedure is departed from in varying degrees by different manufacturers. The exact procedure may be made to depend upon the thickness of the plate. One well-known tank maker welds all square-butted vertical joints in plates 1/4 in. or less with downhill passes, starting on the outside of the tank, but for thicknesses over 1/4 in. up to 3/8 in., he uses upward interior pass layers and downward exterior pass layers. The first pass is made with 5/32-in. electrodes and the others with 3/16-in. electrodes.

For double V grooved vertical butt joints, this same manufacturer uses, for thicknesses less than 1/2 in., downhill backstep layers for the first and outer passes and uphill backstep layers for the intermediate passes. For thicknesses of 1/2 in. and greater, all interior layers are made with uphill back-

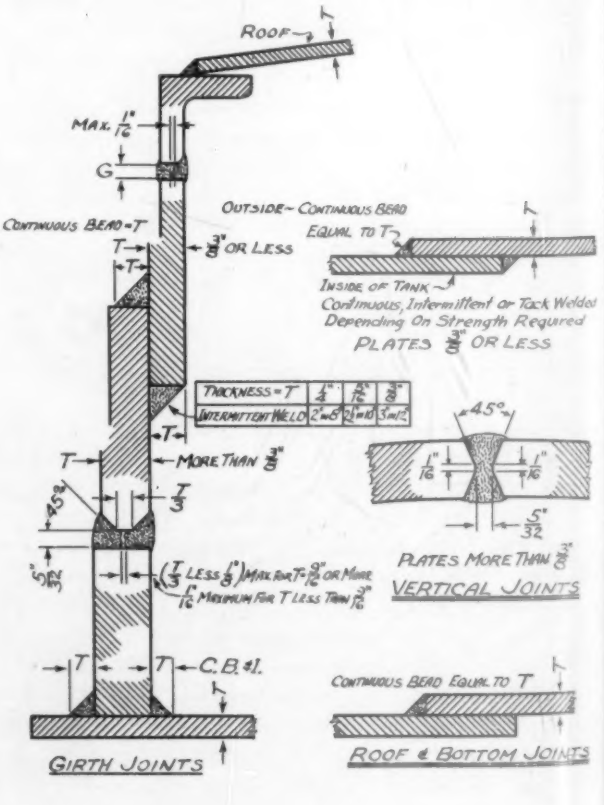


Fig. 4—Welding details for cylindrical storage tanks with shells partly lap-welded and partly butt-welded. Drawing (Chicago Bridge & Iron Co.).

Fig. 5—An 80,000 bbl. oil storage tank under construction. Diameter 120 ft., height 40 ft. The erection brackets are removed when the tank is put in service. Photo (Chicago Bridge & Iron Co.).

step passes and the outer layers are made with downhill backstep passes. The first pass is laid with 5/32-in. electrodes, the others with 3/16-in. electrodes. The first welding on vertical joints is on the outside of the shell, but the first welding on the girth joints is on the inside.

Butt-welded girth joints (horizontal) are almost always made with stringer beads so laid that the finished weld looks as if it were formed by a number of parallel wires or strands nested in the groove. All of the girth joints of Figs. 3 and 4 are made with 3/16-in. electrodes. For shell thicknesses less than 9/16 in., not more than 1/16 in. is left unwelded at the center of the plate; for thicknesses of 9/16 in. and more, the center gap left unwelded is not allowed to exceed 1/3 of the plate thickness less 1/8 in. Such partial fusion of girth joints meets the requirements of A.P.I. Standards No. 12-C.

It is no longer considered advisable or necessary to drill or punch holes in plates for assembly purposes. Clamping devices have been developed by which plates are quickly and accurately assembled, and the gap between abutting edges adjusted to and held at the desired amount.

Welding Sequence

To avoid unsightly buckles and dangerous cracks, it is necessary that pieces be welded in proper sequence and with as little restraint as possible to normal shrinkage. For example, the vertical joints in each shell ring of an oil storage tank are fully welded before the ring is welded to the courses above and below. The vertical joints of the lowest shell ring are completely welded, and the lower edge of the ring

welded together, and finally the outer bottom plates are welded to each other and to the interior plates. If the bottom were welded into a complete disk, and then the shell welded to it, cracks along the bottom edge of the shell would likely result, because the shell would tend to reduce in diameter as welding progressed and would be resisted by the nearly rigid bottom.

Pressure Tanks

For field welded pressure tanks, such as spheres, spheroids, and cylindrical shells with hemispherical ends, the joint efficiencies are commonly applied to 13,750 lb. per sq. in. as a base

Fig. 6—Welded spheroid used for water storage. Capacity is 1,660,000 gals. Size—90 ft. in diameter by 47 ft. high. Photo (Chicago Bridge & Iron Co.).

then welded to the outer bottom plates, before the latter are welded to each other, or to the interior bottom plates. The interior bottom plates are next welded into sections, then the sections

for steels having a minimum tensile strength of 55,000 lb. per sq. in. Vessels built under the A.S.M.E. Unfired Pressure Vessel Code are an exception, since the joint efficiencies for

Fig. 7 — A hemi-spheroid, an oil storage tank of new design. Capacity 20,000 bbls. Photo (Chicago Bridge & Iron Co.).

them are applied to 11,000 lb. per. sq. in. as a base for 55,000 lb. per sq. in. steel. Under the A.P.I.-A.S.M.E. Code, the joint efficiency varies with the type of joint, the quality of material, upon use of radiographing and use of furnace stress-relieving. Under this code, the joints of a butt-welded vessel made of A.S.T.M.-A 10 steel, which are neither radiographed nor stress-relieved, would be permitted an efficiency of only 74%. If A.S.T.M.-A 70 firebox steel were used, other factors remaining the same, the efficiency would be 80%. If, in addition to using A.S.T.M.-A 70 firebox material, the joints were radiographed, an efficiency of 90% would be granted, and if the vessel were both radiographed and stress-relieved, using A.S.T.M.-A 70 firebox steel, the design could be based on joints having an efficiency of 95%.

Most pressure tanks for working pressures of more than 5 lb. per sq. in. are completely butt welded. For spheres and spheroids, a single V groove is commonly used. The upper half of a sphere is usually welded from the outside against backing-up bars welded to one of the abutting edges; the lower half is welded mostly from the inside, but a small groove is chipped from the outside, along the apex of the V into good weld metal deposited from the inside, and then filled by means of overhead welding.

The bottom of spheroids are commonly laid directly on the sand or on an earth bed prepared for them, and butt welded from the top side against backing-up strips. The side sheets may be butt welded from both sides, or from the outside only against bars on the inside. The roofs are usually butt welded from the outside.

» «

Arcronograph Records Are An Aid In Training Welders

By JOHN S. THOMPSON*

★ Our welding school has been using an arcronograph constantly during the last three years as an aid in training arc welding students. Results have been helpful both to the students and instructors. This instrument has an impersonal and convincing way of recording the manner in which an electrode has been deposited, and these records have a great deal to do with keeping the student and instructor together in their joint project of getting proper control over the arc.

Very little needs to be said here concerning the operating principles of the arcronograph. It is a highly scientific recording instrument which is wired to the circuit of the welding machine, and which makes a record by means of an oscillating stylus and a moving chart. Indirectly the line traced by the stylus tells how closely the student is holding to the correct arc length at each instant of deposition time. We know, for example, that for a given electrode, with the proper current setting, there is a certain range of arc length which will result in a practically perfect deposit. At this arc length the stylus rests over a certain line or a narrow range of lines on the chart.

Constant Check on Arc Length

Shortening the arc causes the stylus to move to the left, and lengthening the arc moves it over to the right. In extreme cases full length swings to left and right indicate short circuits and broken arcs respectively. Therefore if the stylus traces a line that is entirely within the range indicated for correct arc length, we tell the student that he has acquired perfect control of the arc for that set of conditions—and the deposit always verifies the statement. If we note imperfections in arc control, we find corresponding imperfections in the weld. And that is about all there is to it as far as we and the student are concerned.

In other words, we have simplified the use and interpretation of this piece of equipment as far as possible. We had to. Our school is a modest affair, though fully equipped with essentials, and very few of our students have had any technical training. They are not interested in the technical aspects of the arcronograph; they are not going to be scientists. But they do want to become good craftsmen; and they are much interested in this device which locates their faults quickly and tells

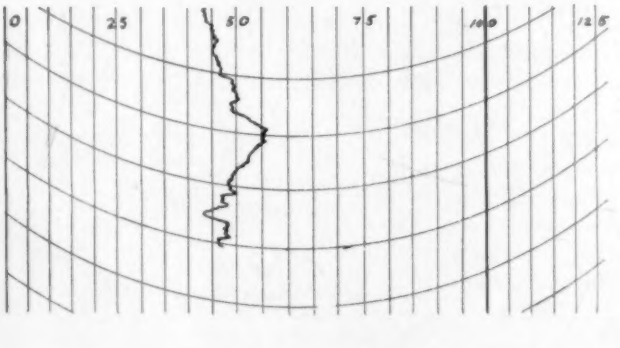


Fig. 1—This student had received 8 lessons in arc welding. Record shows good hand control.

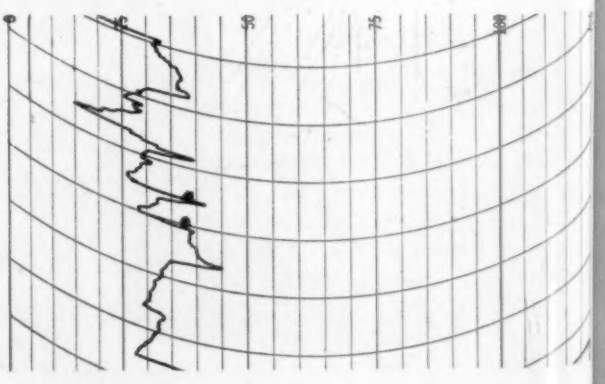


Fig. 2—This record is not so good. Arc length is too short. The man was taking his fifth lesson. He was tired physically.

*Chief Instructor, Electric Welding Service School, Philadelphia, Pa.

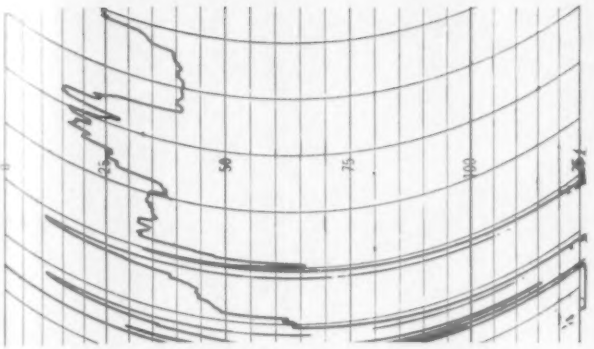


Fig. 3—Record of a beginner taking his third lesson. The wide swings indicate poor deposition of weld metal.

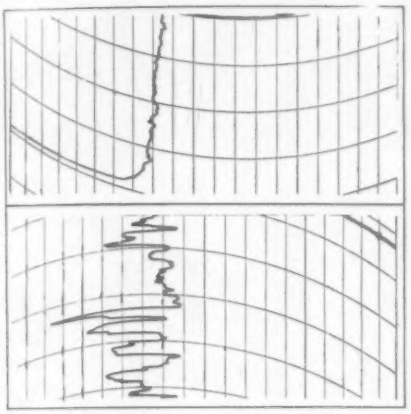


Fig. 4 (Top)—Record of an expert welder depositing a bead with bare wire.

Fig. 5 (Bottom)—The same operator then took a lightly-coated wire and welded with too short an arc. Correct arc length is most important factor in training welder.

them when they have learned to control their welding arcs.

The records shown in Figs. 1 to 3 will illustrate our average routine procedure for using the arcronograph as a training aid, and also how the records are interpreted for the benefit of the student. During a regular evening lesson period the instrument was hooked up to one of the machines, a test plate was placed on the work bench, and each student was asked to leave his station long enough to deposit one bead on the test plate. After he had finished, each student stepped over at once to see his record and after discussing it briefly with the instructor went back to work at improving his control. The record was then torn off, labeled, dated and filed, before the next test is run. Each individual test is a matter between student and instructor. The records shown are the first three made during one session, and required about ten minutes each.

The student whose arconogram is shown in Fig. 1 had received eight lessons. He showed very good control. His hand was getting steady and he was making good progress toward correct arc length, though still holding it too short. The regular cadence of the stylus matched up well with the neat and uniform appearing bead on the test plate. This man had worked as a welder's helper in a good shop and was trying hard to duplicate the kind of workmanship he was familiar with.

The record shown in Fig. 2 is not so good. The arc length is decidedly too short. Yet the cadence is reasonably uniform and we can see that control is growing. Examination of the bead showed that it wavered a bit off the line, and rounded up rather sharply from the plate, but without any bad irregularities. This man was taking his fifth lesson. He had done a full day of hard manual work and then had driven 25 miles to get to his lesson on time. The man was tired physically.

A Beginner

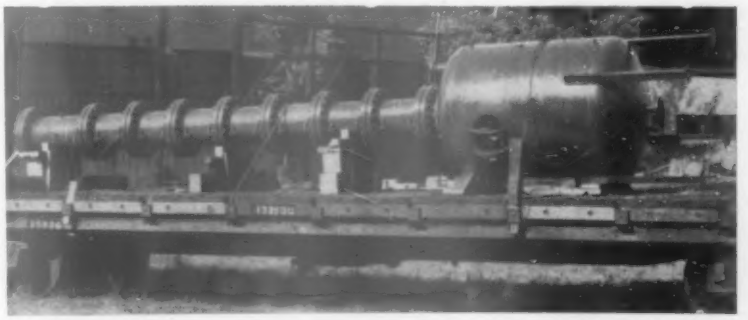
Figure 3 was made by a beginner taking his third lesson. Corresponding to the wild swings of the stylus there were humps and holes in the deposit. In spots he was getting good cadence. This is the time when the arconograph catches the bad habits and outlines them on paper until they are finally conquered.

The subject of arc length is not any too easy to get across to students, either. It is hard for the student to get this distance correctly by watching the instructor, because he sees it then from a different angle. The arcronogram of a good weld gives him something to shoot at, and by magnifying the effect of wrong techniques it guides him systematically to better control. From our experience in the past few years it is evident that a student who habitually produces good arcronograms can hold down a commercial job where he is expected to make good welds.

An Expert

Figure 4 was made by an expert welder laying down a bead with bare wire. The arc controls here is well nigh perfect. Then he was asked to take a light coated wire and weld with too short an arc. Fig. 5 is the result. It is hard to believe that the two records were made by the same man; but he had formed the habit of holding correct arc length and was out of his range when he tried to use a wrong technique.

All the emphasis is thus placed on what we consider to be the most important factor in training, which is mastery of correct arc length. Students can read their own charts well enough to guide their own progress and to give them a better understanding of the suggestions which the instructor makes. For our part, we have been able to dispense with a great deal of breaking of test pieces, because with the arcronograph in the circuit on the test we have the answer as soon as the deposit is completed. Breaking the weld occasionally serves to verify the reading. Instruction time could possibly be shortened by taking advantage of this instrument, but we think that would be risky and prefer to use it as a means of building up a better skill in the same period of time.



Welded high-pressure steel kettle and fractionating column. Photo (Leader Iron Works, Inc).

Fig. 11—A magnetic flame-cutter in operation. A few templates may be seen in the background.

Arc welding economies made possible by

Machine Flame-Cutting

★ Part 2—Advantages of magnetic tracing unit—Multiple-flame shape-cutting equipment—Design of templets—Accuracy pays good dividends

By ELMER E. ISGREN and WALTER J. BROOKING*

Plant Superintendent and Member of Engineering Department, respectively, of R. G. Le Tourneau Inc., Peoria, Ill.

THE MAGNETIC flame-cutting machine such as shown in Fig. 11 is a small, stationary, single torch machine; yet one which is very flexible and is adaptable over a wide variety of jobs. The machine operates on the principle of a torch mounted on a flexible arm which allows the torch to be guided by a motor-driven magnetized drive wheel which follows a steel templet. This construction results in great freedom of manipulation of the torch, but also limits the size of the piece which can be cut to the length of the sweep of the arm.

The variety of cuts which can be made on this type of machine is illustrated by Fig. 12 which shows a few representative cuts on regular production parts. It is unexcelled as a tool for cutting of notches in plates, rounding or bevelling off corners, cutting slots or holes out of parts and making uneven cuts on parts, which are first sawed, sheared, or punched and which need some additional cutting done on them, which cannot be done by the machine which originally cut the part, without costly machining or expensive tools.

One of the advantages of using the magnetic flame-cutter to make the finishing cuts on parts is that in the case of most of the pieces the operator can place the part in the machine, start the flame to cutting, and while it is finishing the cut on the piece automatically, he can remove the slag from the piece run previously and pile the flame-cut piece on a transportation tray. This saves the slagging time over the hand torch method of making such cuts and avoids delay in the flow of material to and from the machine. Naturally the weight of the piece and length of cut on the piece determines whether or not the operator finishes the part as just described.

Cutting Parts "Double"

Frequently a saving in the original cutting of the part on the saw or shear can be accomplished by cutting parts double as shown in Fig. 13, and then making the finishing flame cut serve the purpose of cutting the pieces apart. Many parts partially nest, so that only the width of the kerf has to be added to the double cut in order to accomplish a saving of nearly half of the first cutting cost, as well as a substantial saving of material. Naturally the handling is also reduced.

*Part 1 of this series of articles on "Machine Flame-Cutting" was published in the January, 1940 issue, pages 35-37.

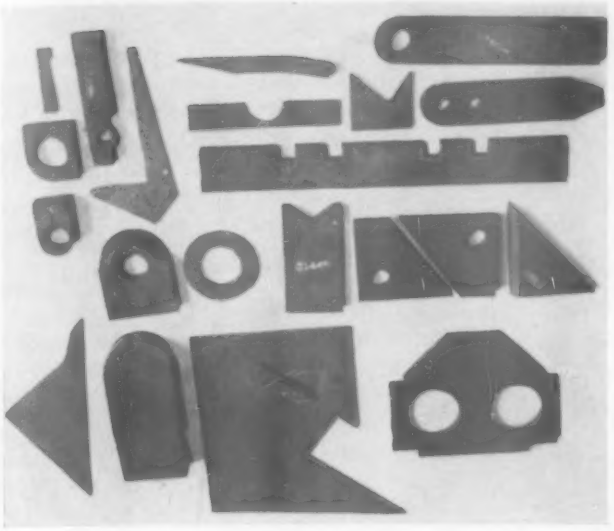


Fig. 12 — An endless variety of notches, radii, irregular cuts and finishing cuts can be made profitably with a magnetic flame-cutter on sheared or sawed parts. Most of the holes in these parts are drilled or punched.

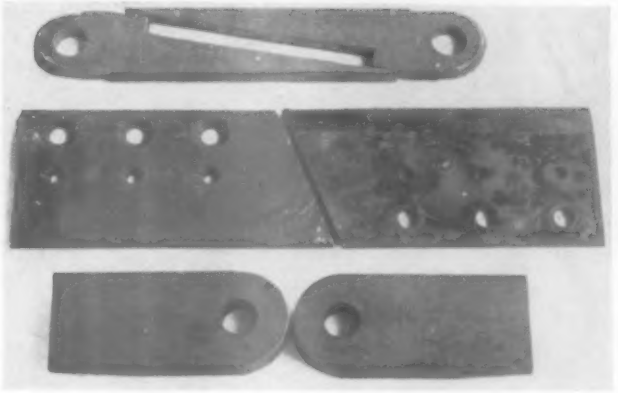


Fig. 13—Irregular ended parts from bar stock may often be cut double, the flame cuts serving to part them.

cuts made by a skillful hand torch operator.

The first step in the economy of using a multiple-flame shape-cutter on production jobs is taken by the progressive designer of arc welded machinery. By the use of large plates of rolled steel in standard sizes, he effects his first saving. The next economy lies in the freedom to cut curves, arcs and circular sections which result in minimum weight with maximum functional design and a fundamental saving of material. The plate shown in Fig. 16 is designed to give the maximum effectiveness in the use of material (see Fig. 4, in which the plate in Fig. 16 is the top plate), and also is designed to reduce scrap and excess weight to a minimum.

Along with a fundamentally "streamlined" machine, the skillful designer can often so fashion the parts of a member that they dovetail or stack as illustrated by the parts in Fig. 17, where the ratio of use of parts in the completed machine is one of the outer, web-like frames to two of the doughnut-like rings, and where the two rings are cut from the piece removed from the inside of the frame, resulting in good utilization of plate with a minimum of scrap. Frequently parts

Bevel cuts which are shorter than the sweep of the arm of this machine can be made, as illustrated by the parts shown in Fig. 14. Both of the parts shown are cut from 1½-in. steel plate and then the bevels are cut on the magnetic flame-cutter. A much more uniform and economical cut can be made mechanically than by hand in scarfing or bevelling such parts.

Fig. 14 — Mechanically flame-cut bevels insure uniformity, smoothness, and accuracy on chamfered or bevelled parts. Both of these plates are 1½ in. thick.

Multiple-Flame Shape-Cutter

The machine, such as the two shown in Fig. 15, are the real production flame-cutting machines. The size of the pieces which they can cut is limited only by the length of the ways on which the torches are mounted and the longitudinal travel of the main carriage on the rails. The two machines shown will accommodate a 96 in. x 240 in. plate ranging from ⅛ in. up to 10 in. in thickness.

One templet and two, three, or four (usually three) torches are used. The time required to cut three pieces, each exactly alike for all practical purposes, is about the same as for one, and the smoothness and uniformity of the cut is much superior to that of the same

Fig. 15 — A pair of multiple-flame shape-cutting machines on production work.

Fig. 16 — How else except by mechanical flame shape-cutting would you make this part out of 1-in. steel plate?

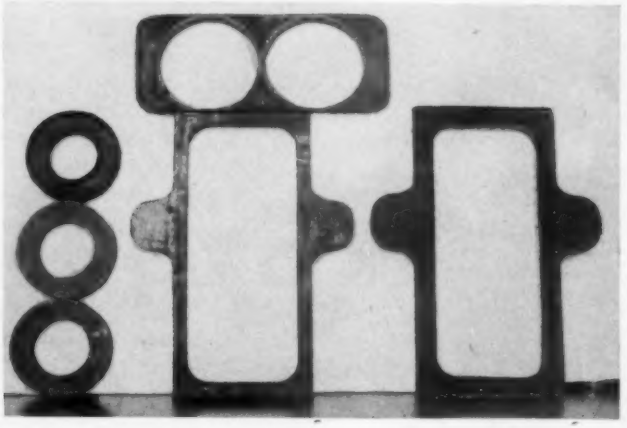


Fig. 17 — Parts which nest shown with their templets. Scrap is shown above the center part.

whose sides curve on long regular radii can be cut from plates in such a way that they nest and save a cut on each piece, since the cut for one side of the piece also serves for the succeeding piece.

Templets for Flame-Cutting

The most important tool or accessory used with a flame-cutting machine is the templet. They may be classified according to the amount of duplication desired for the job on which the templet will be used. In the case of many jobs, where only one or two parts or even ten or a dozen parts are all that ever will be made, the original, full-sized templet made from heavy paper can be used on the flame-cutting machine and simply traced by a tracing attachment on the guiding member of the machine.

For larger production jobs, however, when the number of parts to be cut justify the expenditure of a little time and the cost of a little material, the original heavy paper templet from the engineering department is reproduced in metal, or some other suitable material, with such minor adjustments to size and form as to adapt it to the machine which is being used in order to produce a perfect duplication of the original paper templet in the steel parts as cut. Fig. 18 shows a representative group of templets illustrating one type of templet used for production jobs. All of those shown (Fig. 18) are comparatively small ones, the largest one being only about four feet overall, but they serve to illustrate the type of templet and variety of shapes that can be cut on a mass production scale by a multiple-flame shape-cutter.

Accuracy Pays Dividends

A word should be said about the dividends which careful workmanship will pay in the use of flame-cutting machines and their templets. As in all cutting, shaping, and forming of parts for arc welding, the margin of profit often is determined by the degree of perfection of the fit-up of the parts. Flame-cutting machines cut with precision and accuracy to very close tolerances, without any sacrifice in time of operation; but it requires that: (1) the machine be properly set up, adjusted and in first-class repair; (2) the templet, whether heavy paper or permanent, be made *exactly* to the form which will give an accurate duplication of the pieces desired; and (3) the operator of the machine constantly exercise his care and skill to keep the flames properly adjusted, the speed of the cut correct for the thickness of the material and the other necessary elements of the operation properly under

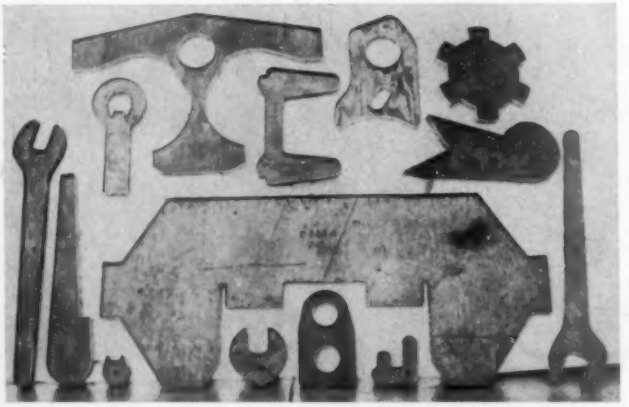


Fig. 18 — Templets for a multiple-torch shape-cutter, ranging from a few inches to several feet in size, and of almost any desired shape, insure faithful duplication of parts on a large scale.

Fig. 19 — Simple steel templets on a magnetic flame-cutter mechanically accomplish irregular cuts on parts with speed and accuracy.

control. Complete conformity with these three essentials allow for maximum economy in the use of flame-cutting machines.

The type of flame-cutter used automatically determines the type of templet which is employed for the job. A portable (or tractor) cutter functions without either paper or prepared templet because it is controlled by either a guide rail or radius rod.

The magnetic flame-cutting machine requires a steel or ferrous alloy templet like those shown in Fig. 19, since the driving mechanism depends on magnetic pull to give it traction as it follows the form of the templet. An evident advantage of such templets is that they are permanent, and can be used as long as the part remains unchanged in form. Templet *A* in Fig. 19 is one to which a small piece was added, due to a change in the form of the part. The little point immediately to the left of the letter *A* was added by welding a short rod to the original templet, and it serves the purpose very well. The templet labelled *B* is used to cut a radius on a bar or a round notch from a part; *C* is a straight-line cutting templet; *D* is used for cutting out a square notch from a plate; *E* is used for cutting the tangent and radius form outside and a rectangular cut out on the same piece; and *F* is used for outside radius cuts as well as inside radius segment cuts. The little nipple protruding from the face of each templet is the bolt used in attaching it to the frame of the machine.

(Part 3 of this article will be published in the March, 1940 issue.)

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Approval of Electrodes For Welding Unfired Pressure Vessels

★ Rules for construction of unfired pressure vessels are covered by the A.S.M.E. Boiler Construction Code* issued by the American Society of Mechanical Engineers, 29 W. 39th Street, New York City. The quality of weld metal and methods of testing joints for various classes of arc-welded unfired pressure vessels are given in Paragraphs U-68, U-69, and U-70. As an indication of the quality of weld metal required, these extracts are quoted:

U-68—"The tension-test specimen of the weld metal shall be taken entirely from the deposited weld metal and shall meet the following requirements:

"Tensile strength. The tensile strength shall be at least that of the minimum of the range of the plate which is welded.

"Elongation. The minimum elongation shall be 20% in 2 in.

"Free-bend ductility. The ductility as determined by the free-bend test method shall not be less than 30%.

"All longitudinal and circumferential welded joints of the structure shall be examined throughout their entire length by the X-ray or gamma-ray method of radiography."

U-69—"Tensile strength. For the reduced-section tension-test specimens, the tensile strength shall not be less than 95% of the minimum of the specified tensile range of the plate used for double-welded butt joints or 85% for single-welded butt joints.

"Free-bend ductility. The ductility as determined by the free-bend test method shall not be less than 20%.

"Soundness. The root-break, side-break, and nick-break tests of the weld shall show in the fractured surface complete penetration through the entire thickness of the weld, absence of oxide or slag inclusions, and a degree of porosity not to exceed six gas pockets per sq. in. of the total area of the weld surface exposed in the fracture, the maximum dimensions of any such pocket not to be in excess of 1/16 in., or provided the total area of the gas pockets per sq. in. does not exceed the area of six gas pockets each 1/16 in. in diameter.

"X-ray tests of the test plates as provided for in Paragraph U-68 may be substituted for the nick-break test."

U-70—"Tensile strength. For the reduced-section tension-test specimen the tensile strength shall not be less than 85% of the minimum of the specified tensile range of the plate used. In no case shall the tensile strength be less than 42,000 psi.

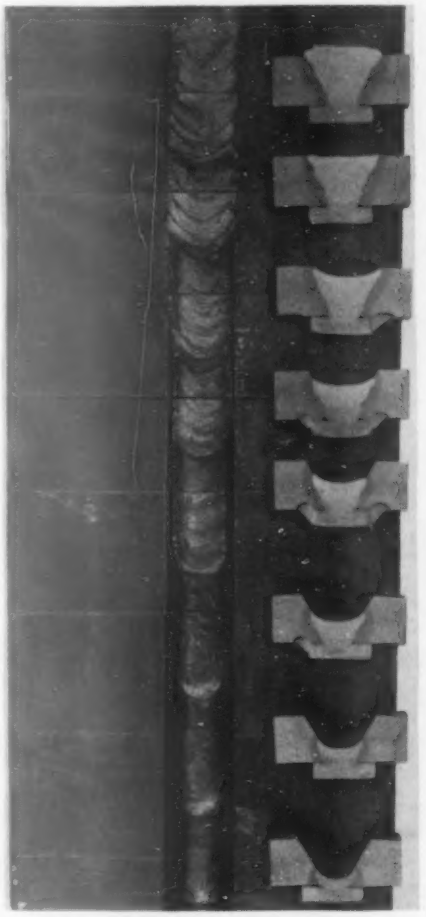
"Free-bend ductility. The ductility as determined by the free-bend test method shall be not less than 10%.

"Soundness. (Same as Paragraph U-69.)"

Electrode Approval

Approval of electrodes for use on marine construction work, boilers, pressure vessels, pressure piping, etc., has already been obtained by the electrode manufacturer, or can be obtained without difficulty, in cases where such approvals are required by insurance companies, regulatory bodies, or other authorities. Methods of obtaining or certifying such approvals are as follows:

(1) Hartford Steam Boiler Inspection and Insurance Co. insures boilers, pressure vessels, turbines, engines, and elec-



"Appearance Weld" photo as required by Hartford Steam Boiler Inspection & Insurance Co. for approval of process on code work. Photo (Metal & Thermit Corp.).

*These excerpts are reprinted from "Arc Welding Electrodes," a recent publication of the General Electric Co., Schenectady, N. Y.

tric equipment against damage resulting from accidental failure, and follows the practice of making periodic inspection of all objects which it insures. In addition, it makes shop inspection during construction of boilers and pressure vessels constructed under the requirements of the A.S.M.E. Boiler and Pressure Vessel Code. The purpose of these inspections is to satisfy itself, through its inspectors, that the welding procedure used will produce welds that meet the requirements of the Code, and that the welding operators are competent as demonstrated by tests which are specified by the Code and conducted by the manufacturer of the boiler or pressure vessel. However, the Hartford Steam Boiler Inspection and Insurance Co. does not itself certify or qualify the welding operators, nor does it approve or certify the electrodes, or other equipments, used in the fabrication of the object. Any electrode may be used, provided it will produce results which meet the requirements of the A.S.M.E. Code.

New Simplified Procedure

Requirements for the construction of various classes of pressure vessels are definitely outlined in the A.S.M.E. Boiler Code. To satisfy the Hartford Steam Boiler Inspection and Insurance Co. that the completed vessel meets these requirements, the following simplified procedure can be used:

For vessels built to comply with requirements of Paragraph U-68, no special assurance need be provided, since the test specimens and radiograph examination of completed joints provide adequate information.

For vessels built to comply with requirements of Paragraph U-69, the pressure-vessel manufacturer should:

(1) Use electrodes "certified" by the manufacturer to comply with A.W.S. Specifications for filler metal, Grades 10 or 15.

(2) See that weld metal is deposited in such a manner as to obtain the appearance given by a standard "appearance weld," a photograph of which should be attached to the welding specification.

Pressure-vessel manufacturers who have previously satisfied Hartford Co. that they have a process for welding which will meet the requirements of the A.S.M.E. Code are not required to make "appearance-weld" photographs themselves, but may use such photograph supplied by the electrode manufacturer.

Pressure-vessel manufacturers employing Hartford for their shop inspection work for the first time are required to make their own "appearance welds." Plate thickness must be equal to the maximum when welding is done from one side only, or on a thickness equivalent to the deeper groove when welding is done from two sides. Such "appearance welds" are prepared in the flat position.

For vessels built to comply with requirements of Paragraph U-70, the same procedure should be followed as outlined for Paragraph U-69.

(2) American Bureau of Shipping—Electrodes used for construction of hulls, boilers, and other structures insured by this company must be approved by it. No further tests of deposited weld metal from approved electrodes will be required, except for the purpose of qualifying operators, provided certificates are supplied, certifying that the types and sizes used have been tested and approved by the American Bureau of Shipping.

(3) Lloyd's Register of Shipping—Electrodes used for construction of hulls, boilers, and other structures insured by Lloyds must be approved by Lloyds. No further tests of deposited weld metal from approved electrodes will be required, except for the purpose of qualifying operators. Certification of this fact can be obtained from Lloyds' local district office or from the manufacturer from whom you purchase electrodes.

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Welders!—Look To Your Cables and Cable Connections

By R. L. TOWNSEND*

★ A study of cable connections on electric welding equipment in the large production shop, or even in the shop with one machine will in many cases reveal a power loss from several angles. Welding cable connections have long been taken for granted and overlooked by those in charge of welding when trying to improve the quality and production in their shop. These companies protect themselves from "operator complaint" by purchasing the best in welding machines.

Ordinarily a new machine gets a new set of cables, lugs, connectors, a holder and copper ground clamp. After once installed, these items are ordinarily dismissed from further attention until they will no longer carry current due to a complete breakdown. Then the machine, job and operator is "down" until a hurried repair can be made.

Where large numbers of welding machines are used cables and connections should have a routine checkover time by the equipment maintenance department. This can be done during shop working time, but better by having the operators check their cables in at regular intervals for inspection and repair. Repairing a cut cable or poor connection at the right time may save burning up a holder or shortening the life of the cable. The time between checkovers will depend upon the usage.

Systematic checking will correct the following common failures:

1. Loose lugs on the welding cable or machine terminals.

2. Loose cable connectors or cable splicers.

3. Broken cables due to mechanical injury or burned insulation.

4. Heating electrode holders due to poor connection, insufficient leverage on jaws due to holder failure or use of too small equipment (including both holder and cable) for work required.

5. Troublesome ground connection due to using inefficient equipment with poor cable connection.

Many efficient cable connections are on the market today. The trend is to a mechanical type of connection, due to quickness and elimination of "melted joints" which is typical of soft solder where high amperages are used. In maintaining mechanical cable connections it must be remembered that expansion and contraction will in time loosen the best of these and corrosion is more readily active than in a soldered joint. Upon signs of heating, a mechanical connection should be tightened or reset in new clean strands of cable.

With proper maintenance of cable connections, savings can result from:

1. Longer life for the cable as well as electrode holders, cable lugs, cable connectors and ground clamps.

2. Greater efficiency in distribution of current due to proper conductivity without loss.

3. Longer welding machine life due to lower machine settings required by efficient cables and connections.

4. Better operator satisfaction and better welds with less loss of time for "equipment fumbling."

5. Increased safety where equipment failure and loss of time is paramount.

Purchasing departments and men in charge of maintaining electric welding equipment should cooperate by purchasing the best in cable and cable connections. Properly maintained, the best cables, electrode holders, ground clamps, lugs and connectors will be an investment in efficiency.

*Proprietor, Tweco Products Co., Wichita, Kan.

Various steps in hard-facing a fish-tail drilling bit. Fig. 8 shows bit prepared for hard facing. Fig. 9 shows how grooves are filled individually. The completely hard-faced drill is shown in Fig. 10

Fig. 8 Fig. 9 Fig. 10

Analysis of fundamental factors

Hard-Facing Technique

★ Part 3—Length of acetylene "feather" in flame exerts definite effect on hardness of deposit—Recommend three-times-normal acetylene flame — Hot peening increases hardness

By T. B. JEFFERSON

Engineer, Marine Design Section, Chief of Engineers, War Department, Washington, D. C.

IN THE SECOND ARTICLE of this series* there was shown the results of a test to determine by which of the various welding processes the hardest deposit could be produced. The results of these tests indicated that those hard-facing deposits made by the oxy-acetylene welding process were the hardest. It was believed, however, that the length of the acetylene flame, i.e., the ratio of the length of the acetylene cone or "feather" to the inner cone of the flame, may also have a definite effect upon the hardness of the hard-facing deposit.

This theory was proved by a series of test specimens, each of which were produced by depositing hard-facing materials by use of different length acetylene flames. The test was begun using a neutral (normal) flame while depositing the first specimen. In each subsequent test deposit, the length of the acetylene cone was increased by increments; each increment equal in length to the length of the inner cone of a neutral oxy-acetylene flame. The series was concluded when the acetylene streamers had been increased to four times the length of a neutral flame.

When attempts were made to deposit hard-facing materials using an oxy-acetylene flame, which had an acetylene cone in excess of four times its normal length, considerable difficulty was experienced in bringing the base metal to a fusion heat.

During deposition those hard-facing deposits made at twice the normal length acetylene cone gave promise of producing the hardest and most satisfactory specimens. Consequently two additional sets of specimens were made with this flame adjustment. The specimens from one of these sets were quenched in water as soon as they were completed. The other set of specimens was thoroughly peened upon completion. Each specimen received its respective treatment while still in the "red hot" stage from the heat of welding.

A description of the specimens and the hardness results obtained in this complete series of tests are recorded in Table 4. The hard-facing material used in the tests was of the ferrous

*Part 1 was published in the December, 1939 issue, pages 37-39. Part 2 was published in the January, 1940 issue, pages 32-34.

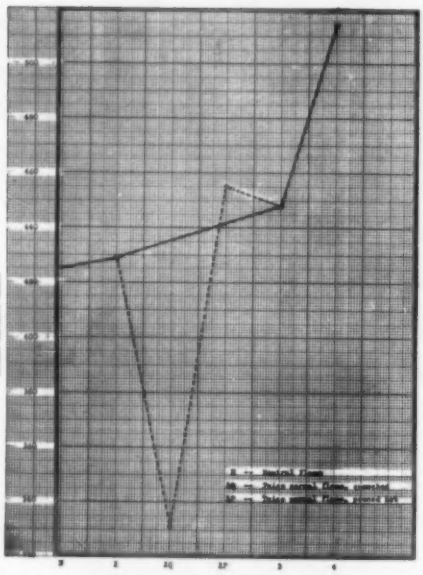

Fig. 6—Hardness of deposit increases as length of acetylene streamers in flame are increased. N = neutral flame. 2Q = Twice-normal flame, quenched. 2P = Twice-normal flame, peened hot. Note that quenching reduced hardness of overlay.

alloy type—Group 1 b (refer to December, 1939 issue, page 38).

The hardness of the hard-facing deposit increases as the length of the acetylene streamers in the welding flame are increased. While there appears to be no direct ratio between the hardness and the length of the acetylene cone; there was a noticeable change in hardness with each change of flame length. When the acetylene cone was increased from three times its normal length to four times its normal length the greatest change in hardness was noted. This change produced an average increase in the hardness of the deposit of 66 Brinell points. The change from a neutral flame to one having twice the normal length acetylene cone, however, made only 5 Brinell points difference in the hardness. (See Fig. 6.)

Recommended Flame

While the hardest deposits were produced during the use of an oxy-acetylene flame, in which the acetylene cone was four times as long as the inner cone, it is not believed that this type of flame is suitable for commercial use. The chief objection to its use is that the acetylene "blast" was so great that difficulty was experienced in bringing the base metal to a fusion heat. In view of this it is believed that the most satisfactory hard-facing deposits will be obtained by using a flame similar to that pictured in Fig. 7, i.e., a three-times-normal acetylene flame

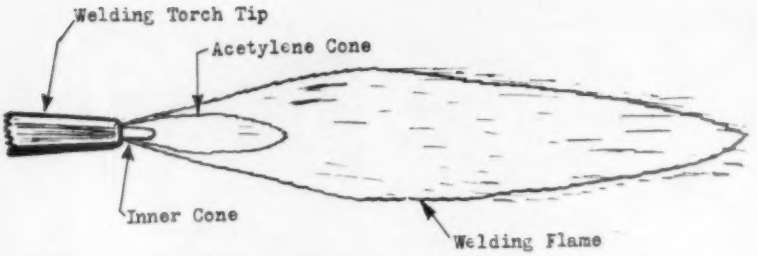

Fig. 7—This type of flame (about 3 times normal acetylene flame) is believed to produce best type of hard-facing deposit.

even though the deposit will not be the hardest.

The use of a three-times-normal flame, which is excessively carburizing, precludes any possibility of oxidation of the deposited metal. Also, because of its carburizing effect, such a flame increases the rapidity with which the base metal may be heated; thereby increasing the speed of deposition of the hard-facing material.

The supplementary tests designed to determine the effects of quenching and peening upon ultimate hardness of a hard-facing deposit indicate that quenching in water has a detrimental effect upon the overlay. In this series the hardness of the quenched specimens averaged 98 Brinell points below those specimens allowed to cool in a normal manner. On the other hand, hot peening of the specimens increased their average Brinell number 26 points above the average Brinell number of the similarly produced specimens not receiving this treatment. The peened deposits also averaged 7 Brinell points harder than those made using the next

TABLE 4—Effect of Acetylene Flame Upon Hardness

Specimen No.	Type of Specimen	Brinell Number	Remarks
801	Single bead deposit with neutral flame	444	Satisfactory deposit
802	Single bead deposit with neutral flame	415	" "
803	Single bead deposit with neutral flame	415	Cracked under Brinell test
Average		**425**	
804	Single bead deposit with acetylene cone twice normal length	429	Satisfactory deposit
805	Single bead deposit with acetylene cone twice normal length	415	Blowholes in deposit
806	Single bead deposit with acetylene cone twice normal length	444	Satisfactory deposit
Average		**429**	
807	Single bead deposit—twice normal acetylene cone—quenched in water	321	Satisfactory deposit
808	Single bead deposit—twice normal acetylene cone—quenched in water	341	" "
Average		**331**	
809	Single bead deposit—twice normal acetylene cone—peened while "red hot"	444	Hair cracks in deposit
810	Single bead deposit—twice normal acetylene cone—peened while "red hot"	477	" " " "
811	Single bead deposit—twice normal acetylene cone—peened while "red hot"	444	" " " "
Average		**455**	
812	Single bead deposit with acetylene cone three times normal length	461	Satisfactory deposit
813	Single bead deposit with acetylene cone three times normal length	444	" "
814	Single bead deposit with acetylene cone three times normal length	444	" "
Average		**488**	
815	Single bead deposit four times normal cone	514	Satisfactory deposit
816	Single bead deposit four times normal cone	514	" "
Average		**514**	

...er (three-times-normal) acetylene flame. A feature that might be considered objectional with respect to the hot-peened specimens is the network of hair line cracks which appeared on the surface of the overlay upon cooling. It is not believed however that such cracks will have any detrimental effects, so far as the wear resisting qualities of these deposits are concerned, if the overlay is thoroughly bonded to the base metal.

Process Advantages

The oxy-acetylene welding process is used extensively for applying hard-facing materials, particularly on small or thin parts. Better control can be maintained over the deposit, because of the lower operating temperatures of the oxy-acetylene process. The lower temperature also means less penetration and consequently less dilution of the overlay with the base metal; a factor that undoubtedly accounts for the higher hardness of the oxy-acetylene deposits. Likewise, the oxy-acetylene process eliminates "spatter loss" of the materials used in hard-facing and permits thinner and smoother deposits.

These inherent advantages have lead to widespread use of the oxy-acetylene process for the application of hard-facing materials in the oil fields, on construction equipment, highway building equipment and agricultural implement maintenance.

One of the major uses of hard-facing in the oil fields is on drill bits. Drillers in the oil fields have found that hard-faced bits make their work easier since hard-facing makes the bits cut faster and last longer.

In Fig. 8 is shown a fish-tail bit that has been prepared for hard-facing. The front face of each bit wing has been grooved to receive diamond-substitute hard-facing particles of either the rod or insert type. If the rod type diamond-substitute material is used, each groove is filled individually as shown in Fig. 9. When the diamond-substitute inserts are used they are welded in place in the grooves. After the grooves have been filled, the entire face of the wing as well as the reaming edge is overlayed using the rod form of diamond-substitute particles. The completely hard-faced bit is pictured in Fig. 10.

Since the hard-facing has been applied only on the forward face of the bit wing, the bit will remain sharp until the overlay has worn away completely. This is because of the self-sharpening action that results from the faster wear on the unprotected underside of the wing. As this wear takes place the hard-facing deposit in the grooves gradually becomes exposed and begins acting as a number of small plows thereby increasing the cutting capacity of the bit. While this method of hard-facing a bit is more difficult, when compared to merely overlaying the wing surface with hard-facing; it is believed to be the most effective means of dressing a drill bit.

Convincing Proof

The two cultivator shovels pictured in Fig. 11 are convincing proof of the value of hard-facing. Both of these shovels were placed in service on the same cultivator when new and operated the same length of time. The longer shovel however was hard-faced with an application of powdered diamond-substitute particles before being placed in service. Its companion shovel was not hard-faced. In agricultural areas it is not uncommon for shop owners to guarantee that a hard-faced cultivator shovel will outlast three ordinary shovels.

There are many other applications of hard-facing materials by the oxy-acetylene process that are equally as satisfactory as these and in all of these oxy-acetylene applications it should be remembered, that:

(1) Hard-facing deposits for maximum hardness should be made using the longest acetylene cone in the flame that will produce a satisfactory deposit under the existing conditions.

(2) The hardness of the hard-facing overlay will be increased by "hot peening."

(3) A carburizing flame will melt the base metal more rapidly than a neutral or oxidizing flame.

The next article of this series will discuss the electric arc application of hard-facing materials and the effect of welding current upon hardness of deposit.

» «

Manganese steel roller built up by arc welding. (Photo (Hobart Bros. Co.).

Reclaimed Clay Shredder Roller Saves Customer $205

★ The roller of manganese steel (shown above) weighs approximately 800 lbs. and is used as a clay shredder and stone remover in the manufacture of brick. Two of these rollers run opposed to each other and are subjected to heavy wear, due to the stones cutting grooves and the clay hollowing them in the center. The rollers then lose their efficiency and must be replaced unless reconditioned by welding.

Harry's Machine Shop, Tilbury, Ontario, builds up these worn rollers, approximately 14 in. long and 58 in. in circumference with a Hobart 200-amp. machine using 3/32 in. electrodes. Each bead is peened as it is deposited and from 15 to 30 lbs. of hard-surfacing rod is used according to the degree of wear. The roller shown required a total of 29 lbs. of hard-surfacing rod and was completed in 11¼ hours at a cost of $62, or a net saving to the customer of $205. Expensive delay was avoided. This built-up roller will outlast a new roller.

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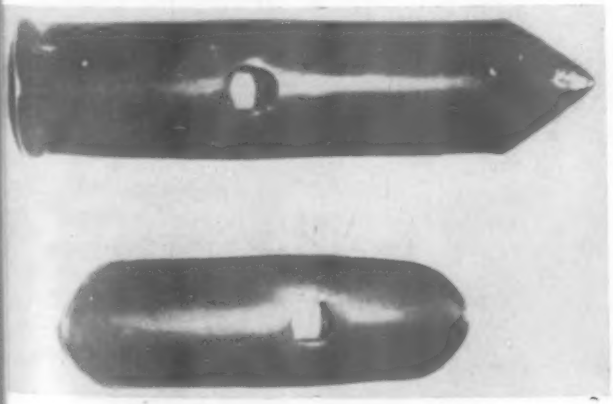

Fig. 11 — Cultivator shovel at the top was hard-faced with tungsten carbide before it was placed in service. Both shovels were placed in similar service and for same length of time

Now Is the Time to Join the
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Repairing a gray iron casting, using the new flux-coated cast-iron filler rod. Note absence of flux can.

Comparison of process techniques for

Welding Of Cast-Iron

★ Use of cast-iron filler metal will produce machineable welds in gray cast-iron, using either the oxy-acetylene process or the electric arc. Minimum preheat—300 deg. F.

By R. J. FRANKLIN

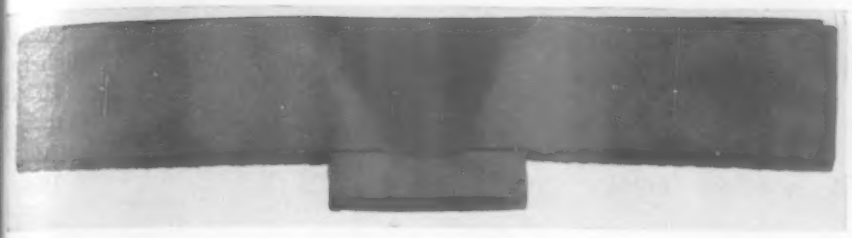
Research Engineer, Chicago Hardware Foundry Co., North Chicago, Ill.

THE PECULIAR physical properties that gray iron castings possess have made the welding of this particular material one of the step-childs of the welding industry, and consequently, most of the art and procedure for welding this metal has been developed by the welder in the field and shop.

In this respect it is somewhat comparable to welding of ten or more years ago, and in another way it is also comparable to steel welding in that in the coming decade it is likely that the welder will be called upon to work with cast-iron that will be alloyed to give varying and improved physical properties. For this reason it is desirable to review the status of the art up to the present, in order that those interested will be familiar with the technique and procedure as it exists today.

Gray cast-iron is a simple alloy of carbon, silicon and iron, and contains exactly the same ingredients as steel, but the carbon and silicon are present in much higher percentages than is found in steel. These higher percentages of carbon and silicon that are present make it possible to vary them over a large range and to use various ratios, and it is this flexibility in composition that makes it possible to obtain cast-iron of varying degrees of hardness and strength.

In commercial practice machineable gray iron castings may vary from 20,000 psi. tensile strength and 150 Brinell, to 40,000 psi. and 200 Brinell. Higher strength castings, up to 60,000 and 70,000 psi. are made by the use of alloys, and will have complete machineability at 275 Brinell. In plain gray iron the expansion, in all cases, is greater than that of steel, it has a lower melting point and little or no ductility. It is these properties of high expansion with no ductility which makes the welding of gray cast-iron somewhat provocative and encourages a welder's best technique. High expansion and low ductility means a tendency toward cracking due to heating and cooling as occurs in welding



Etched macro-section of arc welded cast-iron specimen. The weld deposit is finer grained than the base metal.

A series of machined specimens taken from arc welded deposits laid down in welding two test plates of cast iron. These small tensile specimens are ¼ in. diameter and not the .505 in. standard diameter.

It can be stated definitely that *all* gray cast-iron can be welded. This can be accomplished in all cases by the oxy-acetylene method and in a great many instances with the electric arc. It is desirable that the filler metal be cast-iron, as this possesses the closest approximation to the same physical properties as the parent casting. As in all welding, it is desirable to weld the casting with a rod having as close to the same composition as possible, and there is nothing in the metallurgy of cast-iron which prohibits this.

In some instances, non-ferrous alloys have been used and recommended for welding gray iron castings, but in my opinion these were more or less in the nature of an expedient or makeshift and did not assist in solving the problem, but rather avoided it, and in doing so presented new problems of their own.

Gas Welding of Gray Cast-Iron

Since cast-iron has no ductility it is necessary that the welding procedure have some method to reduce the rate of cooling after a weld has been deposited. This means that a prewarming or preheating should be used. This preheating not only reduces the cooling rate, which in effect is a stress-relieving process, but encourages the formation of graphite which is so necessary for a gray iron weld.

Much has been written and said about preheating, but for the ordinary welder it need not necessarily be a complicated procedure.

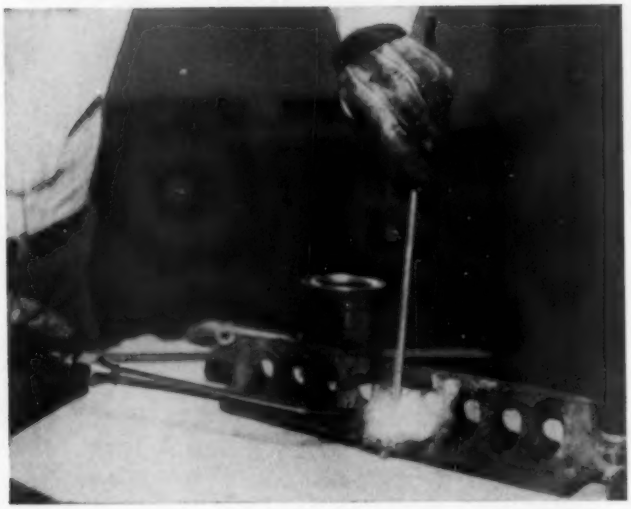
If a casting is small and readily handled, the best thing is to preheat the entire casting. This is especially true if the casting is of irregular shape with varying thicknesses of cross section. Preheating of this nature on a small casting can be accomplished generally with a welding or cutting torch or a kerosene torch. If the casting is a large one, the operator should preheat the area surrounding the weld for about eight inches, to 700 or 800 deg. F., and should then prewarm any irregular section, or juncture where a thin section meets a heavy section, to 300 or 400 deg. F. If there is ever any question as to whether a particular section of a casting is susceptible to cracking, then prewarm it. In the event that the casting is massive and the welding requires several pounds of filler metal it will be necessary to build a charcoal furnace around the casting and maintain the preheating during welding.

The majority of welders, after taking all the necessary preheating precautions and depositing a weld, will then play their torch around the welded area and go back over the section that was prewarmed with the welding torch, bringing this up to its previous temperature. This procedure permits a more uniform cooling rate.

The filler rod for welding gray cast-iron should be cast-iron or low alloyed cast-iron. In the latter case a small percentage of alloy is added to refine the grain structure of the deposit, and provide a stronger, tighter, more leak-proof weld. Rods of this type can be used in place of the regular gray iron rod, and are particularly suitable when the casting has been re-crystallized, due to heat. Straight, unalloyed cast-iron rods should be made of the best grade of material obtainable, free from steel scrap and dirt and containing sufficient silicon to allow for oxidation.

A cast-iron welding rod should preferably be obtained from a source of supply capable of consuming an entire cupola heat in welding rod manufacture, as this insures that no compromise of the analysis will be made for other purposes. The diameter should be uniform and the surface free from occluded dirt and sand. This grade of cast-iron welding rod is now available, with all the necessary fluxes for gas welding present as a coating, and a

Arc welding a small defect in a gray iron casting.



Gas welding a broken cast-iron grate bar. Note the familiar can of flux, always needed, except when the rod is flux coated. Photo (Linde Air Products Co.).

rod of this type insures that each particle of molten metal is amply protected with a flux. The action is somewhat similar to the flux of an electrode. By the use of this method it has been found possible to use a flux that is stronger in its action than has hitherto been available.

Before any welding is started the operator should observe the casting rather closely and determine where the heavy and light sections of the casting lie. In order to reduce the strain in castings to a minimum, it is desirable to weld the heavy section, or the area of least strain first, and the light section or area of greatest strain last. In the event that the weld is to be applied to a heavy and light section it is then desirable to weld from the heavy section through to the light section.

Good Preparation

The technique for depositing filler metal is the same in all instances. A good preparation is essential. If a crack is to be welded it should be veed out so that the vee formation is approximately 90 deg. It is not desirable to vee right through the section as the molten weld metal will burn through and cause difficulty. A 1/8 in. lip should be left. If the casting will lend itself to it, the crack should be double vee'd with enough section at the center of the two vees to prevent burning through. In the event that a hole is to be welded, all sharp corners should be ground or broken out so that a thorough penetration can be obtained, and in the event that the hole is a deep one it should be tapered so that the operator has access to the bottom. In all cases, excess dirt, inclusions and the like should be removed by brushing or grinding if necessary.

In the actual welding operation the torch flame should be neutral and the torch should not be directed at the molten pool, but rather at the tip of the filler rod. As the melting point of cast-iron is rather low, there will be sufficient radiated heat to keep the pool molten and fluid. The operator should watch closely and observe that all the dirt is being removed. Sufficient flux should be present to keep the metal fluid and eliminate oxide and dirt. Any dirt that lays on the bottom of the preparation, or heavy scum on the top of the molten metal, is probably sand and should be lifted or scraped off with the tip of the filler rod. Blow holes can be eliminated by uncovering them with the torch and agitating with the tip of the filler rod which has been fluxed.

Upon starting the weld, a one-half to three-quarter inch section of the walls of the preparation should be at molten temperature and the molten filler metal added to the molten casting metal. This one-half to three-quarter inch section should be fillled with weld metal and the torch removed. The adjacent section should then be brought to a melting temperature and the cast-iron filler rod added. This procedure should be continued until completion of the weld. Upon completion it is probable that the entire weld will be molten or near molten, but it should be kept in mind that the weld metal and casting should not be overheated and burned. Deposit the weld and remove the torch as quickly as possible. In the event that the application requires multiple passes, follow the same procedure as above, making the passes about 3/16 in. in thickness.

During the past, cast-iron has been welded with cast-iron electrodes with varying degrees of success, and it was usually attempted with a bare or lightly flux-coated electrode, using from 1000 to 1200 deg. F. preheating. This technique is not in common usage now.

When cast-iron is electrically welded with a bare cast-iron rod, using no preheat, a hard white iron, unmachineable weld will result. This is caused by the cooling rate being so great as to "chill" the weld zone. As the cooling rate at the edges of the weld is the highest, a hardened fusion line sometimes occurs, but it should be emphasized that the hardened fusion line is not the result of negative dilution, but simply the result of a high chilling rate. This popular misconception of mistaking a hardened fusion line, due to chilling, for one due to negative dilution, led to the often expressed conclusion that a cast-iron electrode could not be developed which would be free from a hardened fusion line.

Shielded Arc Electrode

The solution to this problem was found and there is now available, a small diameter shielded arc electrode with a cast-iron core which will deposit cast-iron welds that will be machineable and not have any hardened fusion line.

To obtain the results claimed by the manufacturer of this product it is necessary that a relatively high welding current be used. This electrode is so designed as to withstand high welding current and the use of a long arc, at the some time obtaining quiet metal transfer.

The high welding current and the arc characteristics of this type of electrode make it possible to obtain intense heat over a wider area than is possible with any other type of electrode. In this respect this electrode simulates gas welding, in that upon completion, the weld metal for two or three inches in back of the crater will be at a red heat and cooling slowly. In order to insure that this cooling rate will be slow enough and to take care of unusual conditions, the manufacturer recommends that a 300 deg. F. prewarm be used prior to the welding operation.

In actual operation, the preparation for welding with the electrode should be the same as for gas welding. All dirt, scale and grease should be removed from the weld area and a 60 deg. vee prepared in the crack. In the event that a hole is to be welded, it

ould be widened at the top to allow manipulation and thorough penetration at the bottom. It is not recommended that this type of electrode be used without a vee preparation.

The prewarming should then be applied and care should be taken that this prewarming actually penetrates into the casting around the weld area. An area three inches on each side and three inches underneath the weld is generally sufficient.

After this has been accomplished, the welding current should be set as recommended by the manufacturer, either a-c. or d-c. and the operator can proceed to deposit a weld, taking care that he holds a medium-to-long arc and that he actually washes the walls of the preparation into the weld metal, obtaining as much dilution and penetration as possible. Dilution will not harm the weld deposit made with this type of electrode, and by washing the walls of the preparation into the weld, the operator actually increases the temperature of the surrounding casting and in this manner delays the chilling rate.

Graphitic Carbon

As a result of this procedure and the formula used in the coating, welds have been obtained in which more than 99% of the total carbon present is in the form of graphite, at the same time obtaining an unusually fine grain structure.

In some instances as in gas welding, trade interests have recommended that non-ferrous base alloys be used for arc welding cast-iron, but in this case a negative dilution which will result in a hardened fusion line may occur. To overcome this a minimum amount of penetration is recommended, which results in a weld with a very poor bond. Any attempt to increase the strength of the bond results in a hardened fusion line, and this type of electrode is at best an expedient.

It should be brought out here that arc welding is not intended to supplant the gas welding of cast-iron, but rather to complement it. When castings are massive, or when very large amounts of metal must be deposited, or castings are excessively dirty, it will be found that gas welding is most suitable; however, in many instances it will be found that arc welding is by far a faster and cheaper method.

The preheating, which is recommended by the manufacturer to assist the formation of gray iron with this type of electrode, should not be confused with the preheating which is necessary to avoid cracking, due to expansion and contraction. In some instances on irregular castings it will be found desirable and necessary to prewarm irregular members to overcome this difficulty just as in gas welding.

Conclusions

Welders, whether in maintenance, production or job shop welding, should not hesitate to weld gray iron castings with cast-iron rods or electrodes. By following recommended procedures and by using the best grade of materials available to him, he can readily make satisfactory welds on cast-iron, which will have the same properties of strength, expansion and color, as the parent casting.

» «

Weld Recorder Improves Production

★ Because the numerous variables affecting the quality of spot welds are not under constant control, General Electric Co. has developed a weld recorder to record and indicate these variations. The weld recorder acts as a recording instrument, signalling device, and lockout control, which measures the electrical input to the spot-welding machine for each spot weld.

With the increased use of welding and the increased rigidity of specifications, sound, dependable welds are a primary requirement. Spot welding is now being used extensively on structural members of aircraft, rail cars, automobiles, buses, trucks, and trailers. Each of these structures is subjected to vibrational stresses of considerable magnitude, and in some of them certain parts must be air-tight and gas-tight. Here, the failure of a single weld might be fatal.

Weld recorder as used in fabrication of airplane parts in plant of Edward G. Budd Mfg. Co. Photo (General Electric Co.).

The new weld recorder is so designed that when the electrical input to the welder (I^2t) varies sufficiently to cause a defective weld, a bell gives a continuous audible signal, and the weld-initiating circuit is automatically opened, preventing subsequent welding until a push-button is pressed. In addition, the recorder chart indicates visually that the weld was not within the pre-set allowable limits for proper welding and shows whether the heat was above or below normal.

The Edward G. Budd Mfg. Co. of Philadelphia, Pa., is using 40 of the new General Electric weld recorders.

» «

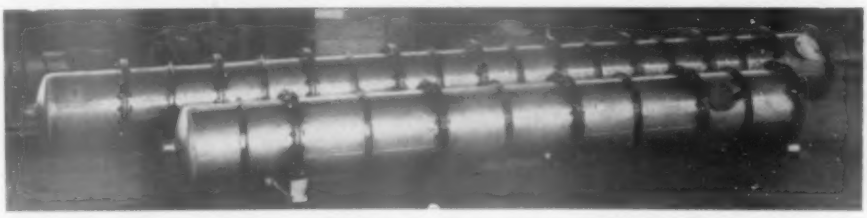
This spider was bronze welded.

Stone Crusher Spider Repaired by Bronze Welding

By R. S. Studzinski

★ As shown in the illustration, a stone crusher spider weighing 9,000 lbs., was cracked through completely on both sides of the main bearing, located in the upper collar of the casting. Each crack measured approximately 20 in. in length and about 6 in. in length and about 6 in. in average depth. Before welding, each crack was chipped and ground to about a 120-deg. bevel. To preheat this huge casting, two large heating torches were employed in addition to a charcoal fire. This pre-heat was continued throughout the entire brazing operation. Two welders were employed simultaneously, one on each crack, using number 12 tips and 3/8-in. bronze rod.

The cost of repairing this broken casting by means of bronze welding was less than half the cost of a new casting. In addition, a month's time was saved by avoiding a plant tie-up waiting for a new casting. The job was handled by The State Welding Co. of Hartford, Conn.



Welded copper stripping and rectifying columns. Photo (Leader Iron Works, Inc.).

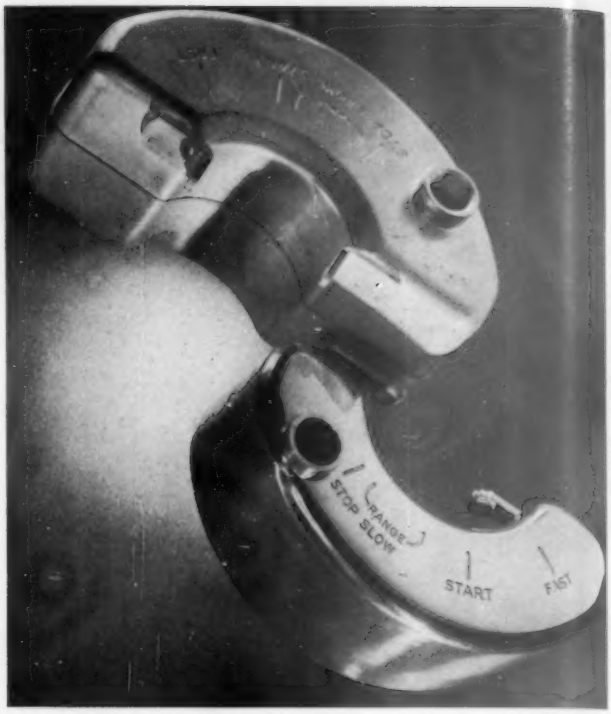


Fig. 1—Brazing is employed to join the two halves of these aluminum gasoline tanks and also attach fittings and brackets. Top—Tank cleaned after removal from furnace. Bottom—Finished tank, brightly polished.

Lower cost

and better finish with

Aluminum Brazed Joints

★ Filler metal of aluminum alloy has lower melting point (1050 to 1185 deg. F.) than parent metal—Three brazing methods described—Good resistance to corrosion

A NEW WAY TO JOIN aluminum alloys is by brazing, which results in neat, economical joints in metal thinner than can be welded by standard arc and gas methods. Brazed joints are lower in cost and require less finishing than torch-welded joints, but have equal strength and resistance to corrosion. The process is suited to quantity production, and is being used commercially to assemble gasoline tanks and refrigerator shelves.

By use of brazing, Johnson Motors reduced welding costs considerably on gasoline tanks for outboard motors. Here, the new method is used not only for joining the two halves of the tanks, but for attaching fittings and brackets. An electric furnace supplies the heat, and a number of tanks are brazed at one time.

In brazing aluminum, as in brazing other metals, the filler material used in making the joint has a lower melting point than the parent metal. The brazing temperature therefore melts the filler material, but not the parts being joined. Since the filler is an aluminum alloy, the finished joint has the characteristics of a welded, not a soldered, job. Aluminum may be brazed by three methods, which differ from each other in the way the heat is applied. These are *furnace, dip* and *torch* brazing.

(1) In the first and most important method, the parts are assembled and fluxed, then heated to the proper temperature in a furnace. The procedure is similar to that used in brazing steel or copper, but the flux, temperature and time are different.

(2) Dip brazing, as the name implies, is done by dipping the assembly to be brazed in molten flux, held at a temperature that will wet the surface of the parent metal and permit the filler material to flow into the joint. In this method, the parts are held tightly in place by means of jigs.

(3) Torch brazing is similar to torch welding, except that the special filler material and brazing flux permit the operation to be carried out with little or no melting of the parent metal.

Details of the brazing process have been worked out for a number of representative alloys with a wide range of mechanical properties. These alloys include commercially pure aluminum (2S), material of higher purity, an aluminum-manganese alloy (3S), an aluminum-manganese-magnesium alloy (4S) and an alloy (61S) containing aluminum, silicon, magnesium, copper and chromium.

The strength of brazed joints in the above alloys is about the same as that of torch-welded joints. Typical

TABLE 1—Typical Values of Strength of Furnace-Brazed Butt Joints*

Alloy	Tensile strength, lb./sq. in.	Yield point, lb./sq. in.	Elongation % in 2 in.
3S	15,000	9,000	7.0
4S	19,000	12,000	3.0
61S	34,000	30,000	3.0

*Sheet is 0.051 in. thick.

values are given in Table 1 and indicate the range covered. It should be remembered that the brazing temperature is above the annealing temperature, and in the case of alloys 3S and 4S, furnace- or dip-brazed parts will return to the annealed temper, no matter how much cold forming has been done. On the other hand, alloy 61S joints have higher strengths since this alloy attains its maximum strength by heat treatment. Higher strengths may be secured in some assemblies if they are rapidly cooled in water or in an air stream after brazing. When maximum strength is essential, parts are reheat-treated after assembly.

Filler Material and Flux

The main requirement of a good filler material is a low enough melting point to provide a practical temperature range at which brazing can be done. It is possible to obtain such a material, with a melting point several hundred degrees below that of aluminum, by alloying the pure metal with silicon, copper, nickel, zinc and other elements. The filler material may be applied as wire or a sheet washer in the same manner as when brazing other metals.

The natural oxide coating of aluminum alloys makes it necessary to use a flux which melts below the brazing temperature and prepares the surfaces so that the filler material will flow into the joint. The flux is supplied as finely ground powder and can be applied to the joint dry or mixed with water or methyl alcohol. While the method of application depends on the type and number of parts, either painting or spraying a mixture has so far proved most economical.

After brazing, the residual flux is removed to improve the appearance of the part, as well as to prevent corrosive attack. While the flux dissolves in water, a more vigorous cleaning is usually advisable. One method that has given good results is to immerse the part in boiling water to remove most of the flux, then dip for 45 to 60 sec. in 5% sodium hydroxide held at about 150 deg. F. This in turn is followed by water rinse, a 1- to 2-min. dip in cold 50% nitric acid, and a final water rinse to remove the acid.

It is frequently desirable to clean the parts prior to brazing. The type of cleaning depends on the amount of dirt or forming lubricant present on the parts, but it is usually sufficient to use a solvent. If this is not adequate, however, an etching procedure similar to that described above is used.

Furnace Brazing

The furnace brazing of aluminum alloys is similar to the same process applied to other metals. The major difference is that the temperature range is lower than that used for ferrous metals.

Batch type electric furnaces have been used in most cases, although conveyor type or gas-fired furnaces should prove satisfactory if designed to operate in the range mentioned. Practically all commercial furnace equipment has the temperature control of 5 to 8 deg. F. which is needed for consistent results.

Furnaces are provided with baffling so that radiant energy from the heating units does not cause local overheating in the load. Then, too, it is important to keep drops of molten flux from falling on the heating units and causing deterioration. Circulation of air in the furnace, while not essential to brazing, is desirable in maintaining uniform temperatures.

No fumes or gases requiring ventilation to the outside air are formed during the brazing period. However, a small amount of hydrogen may evolve when the fluxes are mixed with water.

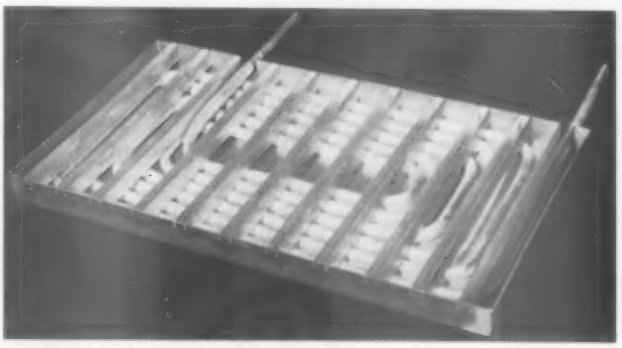


Fig. 3—An assembly of tubing and sheet which has been joined by aluminum brazing.

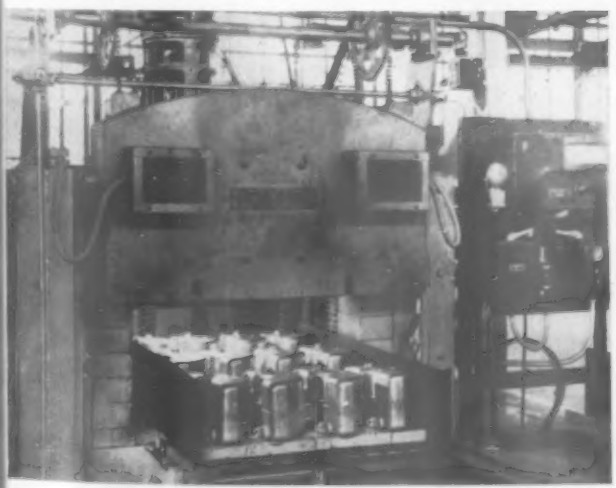


Fig. 2—Type of furnace used for batch-brazing of aluminum alloy parts.

When brazing closed assemblies, this gas must be allowed to escape lest it ignite with sufficient violence to distort the parts. Formation of hydrogen gas may be prevented by mixing the flux with methyl alcohol instead of water, or by drying the fluxed part before it is placed in the brazing furnace.

An air atmosphere has been used for all production jobs so far, and experiments have shown no advantages for the commonly used controlled atmospheres. On the other hand, good results can be obtained with a pure hydrogen atmosphere, although it has not yet been necessary to use this gas.

The brazing time and temperature for a specific part depend on the alloy being brazed, the filler material and the thickness and shape of the parts. With the filler materials now used, the temperature will be somewhere between 1050 and 1185 deg. F., the exact value being determined by trial in each case.

The time in the furnace is equal to the time required to reach the brazing temperature, plus a brazing period of 3 to 8 min. The effect of thickness is shown by the fact that parts 0.008 in. thick have been brazed in 4 min., while parts 0.375 in. thick have required a furnace time of 45 min.

Jigs and fixtures can be used to maintain alignment of the parts if provision is made for differences in thermal expansivity compared with that of aluminum. When steel, stainless steel or graphite jigs are used, the design should be such that the expansion will not distort the aluminum parts. Brass and copper are not used for jigs since they alloy rapidly with aluminum at brazing temperatures if contact is made in the presence of flux.

Because the use of jigs increases the required heating time, the parts are preferably designed so that the assembly is held in alignment by the fit of the parts, by aluminum rivets, or by beading or clinching. Spot welding can be used to advantage if this operation can precede fluxing, and tack welding with a torch is frequently used. Experience has shown that the clearances used will not differ greatly from those commonly used on ferrous metals, except that they should be slightly greater.

Performance of Joints

It has been noted that mechanical strengths substantially equivalent to the values given in Table 1 can be obtained. Pressure tests on some applications have shown that the joints are sufficiently sound to withstand at least 90 psi. air pressure, which value can probably be exceeded considerably. Other tests with water have been carried up to 1700 psi. with no leaks. The tightness of brazed joints should be adequate if the parts have been designed to carry the pressure.

Since the filler materials used in brazing are aluminum alloys, there is little danger of electrolytic corrosion. Tests have shown the resistance to corrosion of a brazed joint to be about the same as that of a torch-welded joint.

Carbon-Molybdenum Plate Has Stainless Steel Cladding

★ Carbon-molybdenum steel is fairly well established as an economical and effective material for elevated temperature service, where temperatures do not exceed 1000 deg. F., and corrosion is not an important factor. Its good creep strength, ready weldability and comparatively low cost make the steel eminently suitable for many elevated temperature applications. Its general use in reaction chambers for oil refinery service is an example.

Improving the corrosion resistance of the steel will widen its field of usefulness considerably. Applications are constantly arising where carbon-molybdenum steel can meet the creep strength requirements without difficulty, but corrosion conditions preclude its use. The most common alternative has been to use a much more expensive alloy steel with the requisite corrosion resistance and adequate creep strength.

How can the corrosion resistance of carbon-molybdenum steel be improved to the necessary degree? The question has been answered by the Babcock and Wilcox Co. by the development of "Croloy Bonded" plate. Essentially the plate consists of thin sheets of chromium stainless steel (C 0.08% max.; Cr. 11-14%; Mo. 0.40-0.60%), continuous resistance welded to a base plate of carbon-molybdenum steel (C 0.10-0.20%; Mn 0.30-0.60%; Mo. 0.45-0.65%). The general construction of the plate is shown in Fig. 1.

The development of this plate was anything but simple, especially since automatic machinery had to be designed to produce it on a commercial scale. Aside from that there were problems connected with the plate itself that presented difficulties. The main problem was how to produce a uniform, permanent bond by spot welding a thin layer of stainless steel to a heavy base plate. By uniform is meant the elimination of all unbonded areas. By permanent is meant a bond that will stand all necessary fabrication processes, the temperature variations in service, and attack by corrosive agents.

As has been stated, the finished plate consists of thin layers of chromium corrosion-resistant steel, electrical resistance welded to the carbon-molybdenum steel base plate. Welding is done by individual spot welds that overlap lengthwise and crosswise on the plate. The uniformity and permanence of the bond is assured by using two or more sheets of chromium steel with a sheet of nickel interposed between them and the base plate, as shown in Fig. 1.

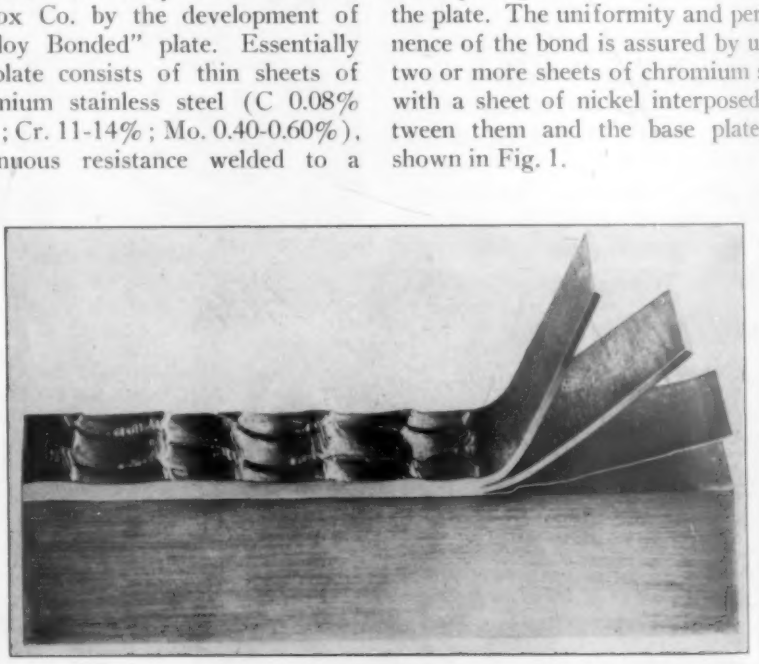


Fig. 1—How the composite plate is built up of two chromium steel sheets, one nickel sheet and the carbon-molybdenum base plate, all welded together by the resistance process. Photo (Climax Molybdenum Co.).

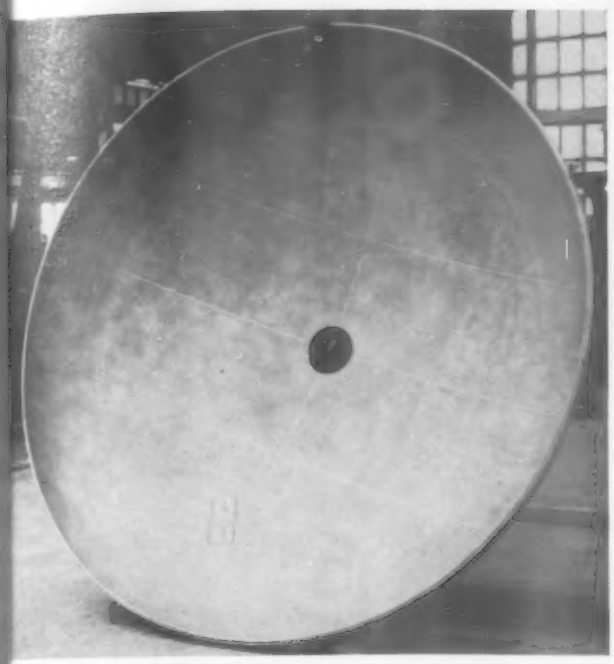


Fig. 2 — Circular head with elliptically-curved dome for an oil refinery vessel. This head was hot spun from "Croloy" bonded plate. A convincing test of strength of bond. Photo (Climax Molybdenum Co.).

This construction provides the electrical resistance necessary for the generation of welding heat by increasing the number of contacts between the electrodes and the base metal. It also reduces the pressure on the chromium sheets necessary to complete the bond. Being thin, the sheets can be pressed into place during welding by lower pressure than would be required in the case of a single sheet of equivalent overall thickness. There is also less distortion of the sheets than would be the case with a single layer applied with greater pressure, while the metal is hot and therefore more readily deformed. Minimum distortion during welding of the sheets results in a veneer of known thickness on the base plate.

The nickel sheet has another and important influence on the permanence and uniformity of the bond. Since nickel does not have the affinity for carbon that chromium has, the interposition of the nickel sheet prevents the migration of carbon from the metal of the base plate to that of the lining. The formation of the band of chromium carbide that usually occurs when chromium steels are welded to carbon-molybdenum steels is thus eliminated. There is no interface precipitation of carbide to render the lining susceptible to corrosion embrittlement when the plate is subjected to high temperatures.

Given Normalizing Treatment

The fact that the bonded plate can be subjected to high temperature without deterioration permits heat treatment after the welding is completed. As a matter of fact, all bonded plate is normalized at 1650 deg. F., to improve the physical properties of the base plate, and to toughen the steel of the lining. Actually, the normalizing treatment is a good test of the permanence of the bond. If the bond was not uniform, and tight, heating to normalizing temperature would cause buckling sufficient to tear the lining from the plate.

Normalizing is valuable from another standpoint, in that it minimizes differences in coefficients of expansion between lining and plate. Otherwise repeated heating and cooling in service might cause the lining to tear away from the plate, and thus bring about premature failure.

As to practical results, experience shows that the bonded plate will stand any necessary fabrication without difficulty. For example, rolling or pressing has no effect on the permanence of the bond. The plate can also be hot formed, or spun just as easily as unbonded plate, and no special precautions are necessary to protect the bond. Fig. 2 shows a hot-spun drumhead 10 ft. in diameter, where the base plate was ¾ in. plate and the lining was 5/64 in. thick. The bonded plate can be punched, or otherwise machined without affecting the tightness of the bond. Punch tests that consisted of drilling the base plate to the lining, and punching through the lining showed no separation of the lining from the plate. Machinability of the plate is proved by the curled chip shown in Fig. 3, where no evidence of separation is visible.

As to welding, the bonded plate can be welded just as easily as unbonded plate. In fact this plate has been found particularly advantageous in the case of vessels equipped with trays, or other internal fittings. In such cases the fittings are fillet welded directly to the chromium steel lining with an alloy welding rod. It is not necessary to cut openings in the lining to permit welding the fittings directly to the base metal. The stress-relieving treatment to which vessels are subjected after welding has no effect on the uniformity, or permanence of the bond.

» «

Fig. 3—Result of machinability test of Croloy bonded plate. Even "plastic flow," such as this, does not cause failure of the bond. Photo (Climax Molybdenum Co.).

NOW IS THE TIME TO JOIN THE

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American Welding Society

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33 West 39th Street
New York City

Brief Sketches of Welding Jobs

Fig. 1—All-welded steel cylinders and reinforcement assemblies ready to be coated and lined with concrete. Photo (General Electric Co.).

Fig. 2—Welding reinforcing rings to steel cylinder section. Photo (General Elec. Co.).

World's Largest Precast Concrete Covered Welded Steel Pipe

★ Welding is playing an important part in the construction of a new pipeline, the largest of its kind ever built, which eventually will carry 300,000,000 gallons of water daily to Boston's Metropolitan Water District. Welding makes this sturdy type of construction possible. Two sizes of pipe are being fabricated by welding, (a) one section 12½ ft. in diameter and 12 ft. long and the other (b) 11½ ft. in diameter and 16 ft. long. Steel cylinders and reinforcing assemblies weigh 45 to 50 tons when sheathed and lined with reinforced concrete.

When completed in 1940 the new pressure aqueduct will be 17½ miles long, connecting Wachusett Reservoir with a distributing point on the banks of the Charles River in Greater Boston. Fabrication of steel cylinders and reinforcement assemblies for this pipe is being made by American Concrete and Steel Pipe Co., under a sub-contract to Lock Joint Pipe Co., of Ampere, N. J.

In fabricating the steel sections, which are later covered with concrete, the steel plates are tacked-welded together to hold them in position for seam welding. To insure maximum strength of these seam welds a special plant has been designed to weld all of these seams automatically. Current for this automatic welding is being supplied by four General Electric 500-amp. transformer-type welding sets.

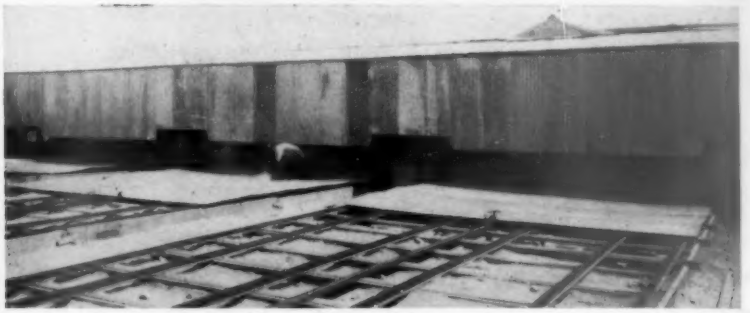

Fig. 4—Tack welding flat plates prior to seam welding. Photo (General Electric Co.).

After this welding operation, the plates are rolled to form a hollow cylinder and the final seam is welded. Bell and spigot rings are next welded in place and the section is then placed on a revolving mandrel where the reinforcing rings are welded on. Welding current for this phase of the work is supplied by motor-generator arc welding equipment, including 20 G-E units. The steel sections, weighing from 5 to 10 tons, is then ready for concreting.

Approximately 7,000 to 8,000 ft. of seam welds are made every day. This figure does not include the tack welding necessary to attach the reinforcement cages to the steel cylinders.

At the present rate of construction, 25 to 30 completed sections are turned out per day. Every 30 min. one of these fabricated steel cylinders and reinforcement assemblies is taken out of the American Concrete & Steel Pipe Co. plant. Each completed cylinder, with joint rings welded to it, is shop tested hydraulically for strength and water tightness.

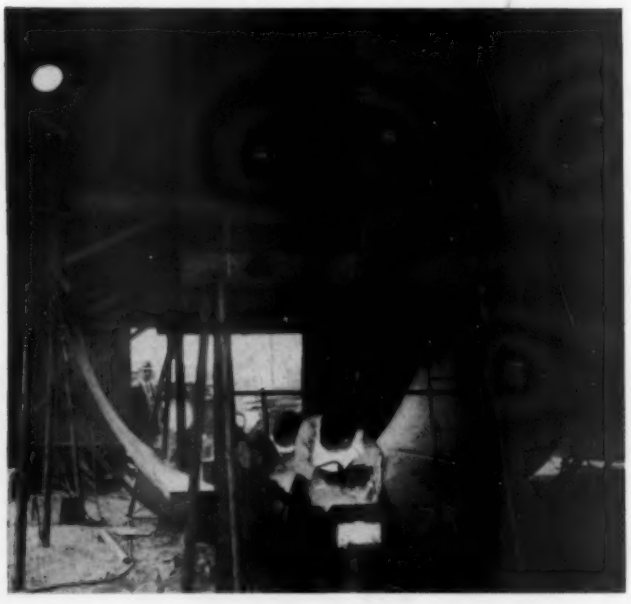

Fig. 3—Making final seam weld in rolled plates. Photo (General Electric Co.).

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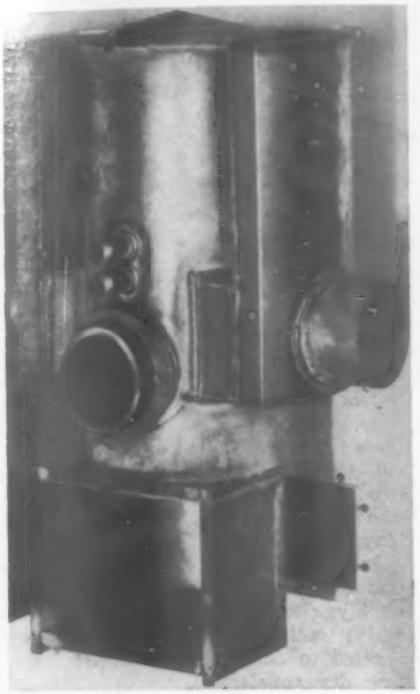
Oil-Fired Combusion Chamber Built by Arc Welding

★ A marked advance in oil-fired furnace construction has been made by the L. J. Mueller Furnace Co., Milwaukee, Wis., in the design of its new unit for home heating. As shown in Fig. 1, the entire assembly is fabricated by arc welding steel sheets of 12, 14 and 16 gauge. Only the combustion chamber and radiator section is shown. The oil burner unit proper is installed in the lower section with the rectangular opening. This particular unit is rated at 100,000 B.t.u.'s per hour maximum capacity. A



Compactly designed welded steel furnace for use in conjunction with an oil-fired burner. Photo (L. J. Mueller Furnace Co.).

special copper-bearing alloy steel is used to improve corrosion resistance.

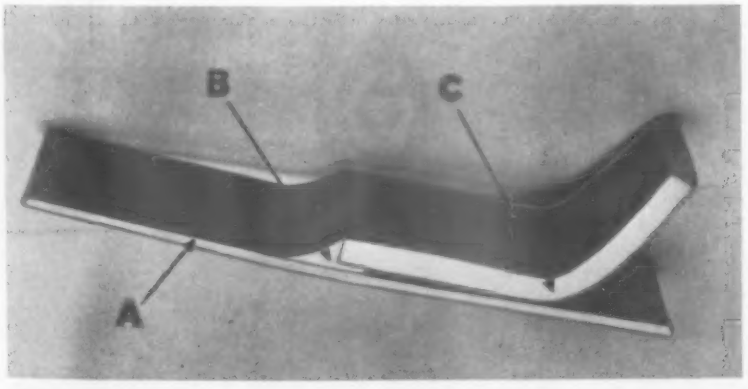
This type of welded steel combustion chamber, used in conjunction with a properly designed oil burner unit, makes possible a highly efficient furnace. Such a heating unit provides a much higher efficiency than when an oil-fired burner is installed in a furnace originally designed to burn coal.

» «

Welding of Copper-Clad Water Heater Tanks

★ One of the leading steel producers has developed a copper-clad steel plate to enable fabricators of tanks and chemical process equipment to make use of a plate material lower in cost than solid copper or copper alloy, and yet possessing all of the desirable chemical properties of copper, plus the mechanical strength of mild steel plate.

Bastian-Morley Co., Inc., La Porte, Ind., a leading manufacturer of automatic gas-fired water heating tanks, is making use of this new composite metal in the fabrication of part of its line of tanks. As shown in the illustration of a section cut through the welded circumferential joint between the copper-clad bottom of the tank (C) and the copper-alloy side wall (A), the oxy-acetylene method of brazing is employed (B) to make a water-tight corrosion resistant joint. The brazing temperature is, of course, lower than what would be needed to melt the steel portion of the plate. After these tanks are welded, they are given a 350 lb. hydrostatic test to locate any possible leaks. Additional tests have been made on an impulse testing machine developed by this company, wherein the pressure in the tank is varied from zero to 300 psi. and back to zero at the rate of 53 cycles per min. One of these welded tanks withstood this drastic test for more than 500,000 impulses. It is estimated that this accelerated impulse test is equivalent to about 50 years of actual service.



Section of brazed joint (B) between copper-clad tank bottom (C) and copper-alloy shell (A). A silicon-bearing bronze rod is used.

Fig. 1 — This welded bridge replaced an older plate girder span with but a 5-hr. traffic interruption.

Welding Simplifies Replacement of Bridge Structure Under Traffic

By FLOYD R. SMITH*

★ Welded construction made possible an improved design and a substantial saving in cost, when continued deterioration of structural members made it necessary for the Union Railroad Co. to replace the plate girder span of the old High Street Bridge at East Pittsburgh, Pa. The original bridge had for its main members, two 48-in. plate girders continuous over three supports. It was built on a 68 deg. skew with High Street and had a trough type floor. These features were entirely changed in the reconstruction. The skew-end masonry was converted to a square end and a new masonry backwall constructed. Plate girders were replaced by two 36-in. WF 300-lb. beams, 39 ft. 9 in. long with two cover plates 14½ x 1¼ in. x 26 ft. attached to each beam by a ⅜-in. full fillet weld. Twenty-two 12-in. WF 79-lb. floor beams were framed into the girders on 1 ft. 9⅝-in. centers. Four 8-in., 23-lb. I-Beam stringers were framed between the floor beams in pairs on 1 ft. 6-in. centers at the center of each rail. The girder bearing brackets on the column end were of welded design, as were the tie supports, tie stops, brackets, sidewalk, column fixtures, etc.

One five-hour interruption of freight traffic, which is very dense at this point, was necessary for setting the new span in place, all other alterations being made with little interruption. The new span was designed by the engineering department of the Union Railroad, and was fabricated, assembled and erected by company forces. Total weight of the superstructure is 88,770 lbs., including 1,704 lbs. of weld metal, applied at the rate of 2.37 lbs. per man-hour. Wilson motor-generator welders and Wilson No. 98 shielded arc electrodes were used for both shop and field welding. The company officials are convinced that they have achieved a very practical type of construction easy to inspect, and economical to maintain.

*Chief Draftsman, Union Railroad Co., East Pittsburgh, Pa.

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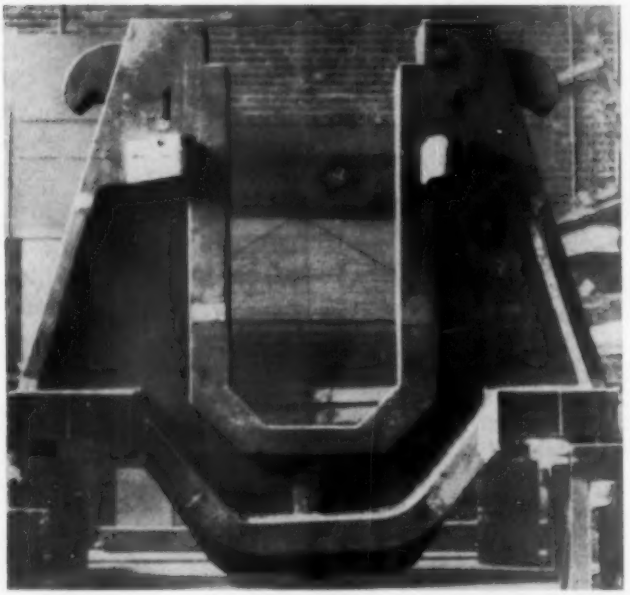
Thermit and Arc Welding Used to Make a Mill Pinion Housing

★ Because of lubrication difficulties experienced with cast-iron housings of blooming mill pinions, the **Andrews Steel Co.**, of Newport, Ky., recently evolved a new type of housing fabricated from rolled steel plate by means of welding.

Somewhat unusual in welded fabrication was the combined use of both the thermit welding process and electric arc welding in the construction of the first of the new type housings. Central members were flame-cut from 8-in. plate in the form of two J-shaped pieces. These two members were then thermit welded together to make a large U-shaped piece, 8 by 27 in. in cross section at the weld. All other members, flame-cut from plate ranging in thickness from 1½ to 8 in.,



Both the thermit and arc welding processes were used in building this fabricated mill pinion housing. Photo (Metal & Thermit Corp.).

were welded to the U-shaped central section by means of arc welding.

Heavy mineral-coated electrodes, depositing weld metal containing .50% molybdenum and having a tensile strength of 68,000 to 73,000 psi., when stress relieved, were used for the electric welding. Joint design included double beveling of all plate edges and the work was positioned so that, with the exception of a few short passes, all welding could be done downhand.

All of the work was preheated before the electric welding was started and the entire assembly was kept at 250 to 300 deg. F., during welding. The welding was done continuously, with two to four welders working in three shifts, so that welding of each joint, once started, could be finished without interruption. About 140 welding hours were consumed, aside from the making of the thermit weld. Prior to machining, the entire structure, including bases and caps, which were fabricated separately, was annealed at approximately 1200 deg. F.

Procedure followed resulted in warping being held to a minimum, and inspection after heat treatment showed that where misalignment had occurred, it was, in most cases, less than 1/16 in. The fabricated housing, 7 ft. 10 in. high and 8 ft. 9 in. wide, weighed when completed, 22,500 lbs., including caps and bases.

Design and construction of the new type housing were handled under the supervision of **A. R. Mitchel,** chief engineer, and **H. Q. Gruell,** welding superintendent, both of **Andrews Steel Co.**

» «

High-Tensile Steel Reduces Weight of All-Welded Barge

★ Recently built by American Car and Foundry Co. for the Hill Dredging Co. of Atlantic City, N. J., this all-welded barge (Fig. 1) will be used for laying dredge pipe. Because of its high corrosion resistance, the high tensile strength of USS Cor-Ten could be utilized to good advantage for weight saving and ¼ in. side and bottom plates were substituted for 5/16 in. plates; 3/16 in. for the ¼ in. bulkhead plates formerly necessary. Bars and shapes were reduced in the same proportions. In the 40-ft. boom, USS Cor-Ten replaced wood with a considerable weight saving.

A weight saving was made possible in this welded barge by using high-tensile (low-alloy) steel. Photo (Carnegie-Illinois Steel Corp.).

» «

Reconditioned 36-In. Pipeline Made Possible by Welding

By CHARLES W. GEIGER

★ An interesting use of a reconditioned 36 in. diameter welded steel pipeline was made by the San Francisco Water Department in constructing the 5.4 mile Palo Alto pipeline from a connection to the Bay Crossing pipeline of the Hetch-Hetchy water supply to Palo Alto, Calif. The pipe used in this line was obtained by uncovering, removing, cleaning and reconditioning a portion of the Corral Hollow pipeline which was built to avert possible water shortage during construction of the Coast Range tunnel of the Hetch-Hetchy water supply, but was never used, and is no longer necessary since the tunnel is completed and in successful operation.

The Corral Hollow pipeline consisted of 24 miles of 36 in., 40 in. and 44 in. welded pipe. As there had been no occasion to salvage the pipe until the construction of the Palo Alto pipeline, the pipe was left in the ground.

Removal of the 36 in. welded steel pipe from the Corral Hollow pipeline was accomplished by "blading" with a bulldozer and tractor down to about 2 in. above the top of the buried pipe. Then using a wheel-type trenching machine, a trench was dug 22 in. wide and 3 ft. deep, parallel to and about 2 in. away, from the pipe. Then the pipe was flame-cut into 60 ft. lengths, loosened from the ground and lifted out. The removed sections were then flame-cut into 30 ft. lengths.

In reconditioning, the old dip coating was burnt off and the pipe was thoroughly cleaned by shot-blasting, after which each section was carefully inspected to determine the extent of pitting due to electrolysis. All pits over ⅛ in. deep were filled with "tack" welds. A coal tar enamel lining and coating was then applied, while the pipe, previously heated to 40 deg. F., was spun at a peripheral speed of 1,100 ft. per min. An unbonded wrapping of asbestos felt was next applied. This reconditioned pipe was then welded into the 36 in. diameter Palo Alto pipeline.

» «

Radio City Remodels Ice Skating Rink

★ Radio City's Sunken Plaza has an outdoor skating rink. Decision was made recently to enlarge the rink and to install permanent rink piping. Heretofore, it had been the practice to lay pipe in the Fall and remove it in the Spring. It would have been possible, of course, by merely laying a new foundation, to make a permanent installation out of the former piping system. However, in order to insure an absolutely leak-proof and corrosion-resistant installation, and to eliminate a mass of threaded joints and the need for periodic tightening of these joints, the contractor, Almirall & Co., decided to join the pipes by oxy-acetylene welding.

This close-up of the welding operation shows some of the completed welds, as well as the method of welding employed by the operators. Photo (Airco).

A welded copper-clad steel steam-jacketed cooker—6 ft. diameter, 4 ft. high. Photo (Leader Iron Works, Inc.).

Welded varnish kettles of stainless clad steel. Photo (Leader Iron Works, Inc.).

News of the Industry

A.I.E.E. Subcommittee Reports—L. W. Clark of the Detroit Edison Co., and chairman of the Subcommittee on Power Supply for Welding Operations, directs our attention to two recent subcommittee reports: (1) "Power Supply for Resistance Welding Machines." (2) "Resistance Welder Installations." Both of these reports can be obtained from A.I.E.E. Headquarters, 33 West 39th St., New York City.

The first report "Power Supply for Resistance Welding Machines" is an outline for the user to guide him in obtaining good electrical performance from resistance welding machines. "The adequacy of power supply and control of current are determining factors in the production of consistently good welds," says the report. An efficient machine of good electrical characteristics and low kva. demand requires a much smaller plant investment for transformers, feeders, etc., than does a machine with poor electrical characteristics, although both machines may deliver the same welding current output.

The second report "Resistance Welder Installations" points out that factory wiring for resistance welding loads must be designed on a different basis than for ordinary power and lighting loads. The report provides technical data upon which a properly designed installation can be made. The Committee recommendations are based on reports received from a number of industrial plants, showing distribution methods successfully employed in existing installations. The report should be helpful to users of resistance welding when planning new installations of equipment.

» «

Omaha Welding Co. 7th Annual Welding Conference—On March 6-8, the **Omaha Welding Co.**, 1501 Jackson St., Omaha, Nebr., will hold the 6th of a series of annual welding conferences to provide as much educational help as possible to users of welding in the Omaha area. Program includes a number of practical demonstrations of gas, arc, and resistance welding. Also on the program are demonstrations of flame-hardening, hard-facing, and oil field welding.

» «

Stainless and Heat-Resistant Steels—Dr. V. N. Krivobok, associate director of The Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa., presented a discussion of stainless and heat-resistant steels and their fabrication by means of welding at the Western Society of Engineers meeting, Chicago, on January 24. Mr. Krivobok explained some of the fundamental problems of corrosion, pointing out why it is so very important that stainless steel equipment be highly polished to achieve maximum resistance to corrosion. He mentioned that the welding process is being used almost 100% in the fabrication of stainless steels, because only by this method is it possible to obtain full corrosion resistance at joints. Stress concentrations are reduced by the welded method of fabrication.

» «

A.I.M.E. Annual Meeting — The 152nd annual meeting of the American Institute of Mining and Metallurgical Engineers was held in New York City during the four days, February 12-15. Owing to the diversified activities of this big organization, the technical program was so planned as to provide a number of simultaneous group meetings. In the non-ferrous metals field alone, there were papers presented on non-ferrous metallurgy, and recrystallization phenomena. The Iron and Steel Division of this organization included papers on the chemistry of steel making, control of surface qualities, carbon and low alloy steels, and diffusion and decomposition in austenite.

» «

Design of Welded Structures—Gilbert D. Fish, consulting engineer on welded structures, who believes that welded structures will ultimately take the place of riveted structures, will direct a course in the design of welded structures during the Spring Term of the **Federation Technical School,** 114 East 16th St., New York City. This is the first time in New York City that a course in this important subject has been offered. The course will be given in seven sessions once a week, beginning Thursday, Feb. 8th, at 6.30 p.m.

1939 Was a Banner Year in Welding Applications

Statistics on welding electrode sales in 1939, just released by N.E.M.A. headquarters in New York City indicate that welding forged ahead rapidly last year. As shown in Table A, electrode sales reached the all-time peak of 152,863,000 lbs. The ratio of electrode sales to steel tonnage in 1939 was 3.33 lbs. per ton. While not quite as high as the 1938 ratio (3.5 lbs.) the figure appears to indicate a continued high degree of acceptance for welded fabrication.

Table A—Trend in Welding Electrode Consumption

Year	Steel Ingots	Welding Electrodes	Electrodes per Ton
1932	13,464,000 tons	18,800,000 lbs.	1.4 lbs.
1933	22,894,000 "	39,000,000 "	1.7 "
1934	25,949,000 "	57,000,000 "	2.2 "
1935	33,940,000 "	77,230,000 "	2.3 "
1936	47,573,000 "	110,330,000 "	2.3 "
1937	50,318,000 "	128,360,000 "	2.5 "
1938	27,742,000 "	97,020,000 "	3.5 "
1939	45,769,000 "	152,863,000 "	3.33 lbs.

Mr. Fish will be assisted by **Robert Soman,** his field inspector and designer. The subject matter has been arranged so that any man competent in riveted construction will be able, at the completion of the course, to design welded structures.

» «

1940 I.A.A. Convention to Meet in Milwaukee

The 40th Annual Convention of the International Acetylene Association is to be held in Milwaukee, Wis., April 10-12. Convention headquarters will be at the Schroeder Hotel. In announcing the selection of Milwaukee for this year's convention, the Secretary (Herb Reinhard) said that this city was chosen because of its importance as an industrial and scientific center. Milwaukee is the home of a number of important and diversified industries, and is within convenient distance from other important industrial centers. A record attendance of engineers, industrialists, and shop technicians is expected. Last year the meeting was held in Houston, Texas.

The program will include a technical forum on oxy-acetylene cutting of metals, a series of round-table discussion meetings, and, on each of the three days of the convention, a group of technical sessions, at which will be presented many papers by outstanding technical men in applications of the oxy-acetylene process of welding, cutting, and heat-treating. Announcements of subjects and speakers will be included in an early issue.

Personals

Edward D. Emerson, since 1937 district sales manager with Babcock & Wilcox Tube Co., New York City, has been appointed general manager of sales for **John A. Roebling's Sons Co.,** Trenton, N. J. Mr. Emerson is a graduate in mechanical engineering, Harvard University, class of 1923. Previous to his employment with Babcock & Wilcox he was for several years sales engineer with the Jones & Laughlin Steel Corp. Mr. Emerson will assume his new duties on March 1st.

EDWARD D. EMERSON.

» «

Clinton E. Swift has been located in Alhambra, Calif., by our "roving news reporter." Mr. Swift is the welding engineer of **C. F. Braun & Co.,** pressure vessel fabricators at Alhambra, Calif. This company is equipped for building vessels in accordance with the ASME-API code for pressure vessels and the ASA code for power piping. Prior to his present connection with C. F. Braun & Co. Mr. Swift was welding engineer for American Brass Co.

» «

C. A. Smith has been appointed manager of the East Pittsburgh factory service division, Westinghouse Electric & Mfg. Co. Mr. Smith, formerly superintendent of the switchgear division at East Pittsburgh, succeeds the late **F. J. Shiring.** He has been associated with Westinghouse since 1892, when he became an apprentice. He has served as assistant foreman, general foreman, assistant superintendent, superintendent, and division manager.

» «

K. L. Hansen, consulting engineer for **The Harnischfeger Corp.,** 4400 West National Ave., Milwaukee, Wis., has been nominated a regional vice-president (Great Lakes District) of the **American Institute of Electrical Engineers.** He will be formally elected at a later date and will take office August 1, 1940.

Trade News

G. E. Orders Up 43% in 1939—Orders received by General Electric Co. during the fourth quarter of 1939 amounted to $112,166,535, compared with $63,419,265 in the final quarter of 1938, an increase of 77%. Orders for the year 1939 were $360,748,386, compared with $252,176,223 for 1938, an increase of 43%. Sales billed and net earnings for the year are not yet available, but will be given in the annual report for 1939, to be issued March, 1940.

» «

$63,899 for New Ideas—Employees of the General Electric Co. in 1939 received $63,899 for new ideas adopted under the company suggestion system. This was $12,497 more than they received in 1938. Cash awards ranged all the way from $2 to a top of $525. During the year, 26,901 suggestions were made by employees, or 6702 more than in 1938. Of this total, 10,121 were adopted.

In the past 20 years more than $1,000,000 has been paid to employees for new ideas and better ways to do the job. More than 300,000 suggestions have been made since 1919. In recent years the percentage of adopted suggestions has increased. Awards paid are not fixed, but are determined on estimated savings and other factors such as ingenuity of the suggestors, etc. Awards have been as high as $1500.

» «

Alloy Rods Corporation has been organized for the manufacture of stainless steel and alloy welding rods. Headquarters and plant are located at 501 East Prospect St., York, Pa. **Edward J. Brady** is vice-president and general manager of the new organization. Mr. Brady was formerly manager of the stainless and alloy division of the McKay Company, York, Pa., and prior to that was sales engineer with the Hollup Corp., Chicago, Ill. The plant of **Alloy Rods Corp.** is expected to be in production on March 1, 1940.

EDWARD J. BRADY.

» «

Glenn-Roberts Co., 1009 Fruitvale Ave, Oakland, Calif., have appointed **Harron, Rickard & McCone,** 2205 Santa Fe Ave, Los Angeles, Calif., as welding equipment distributors for Southern California.

» «

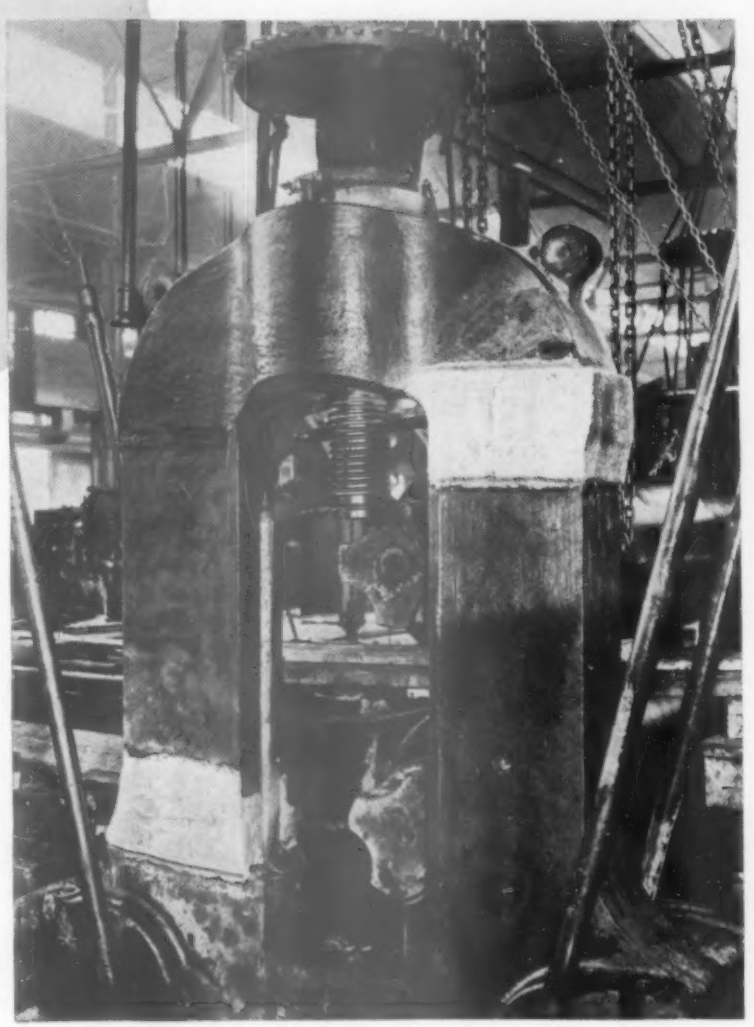
Guide for Welding Metals and Alloys—A valuable guide to welding commonly used metals and alloys has recently been printed in chart form by **The Linde Air Products Co.,** a unit of Union Carbide and Carbon Corp. Recommended welding method, flame adjustment, welding rod, and flux for each of 30 different metals and alloys can be determined at a glance by referring to this handy outline. Copies of this chart, Form 4464, can be obtained without cost by writing to the nearest office of The Linde Air Products Co. or the company's headquarters office, 30 East 42nd Street, New York City.

» «

Suggestions Are Rewarded at Westinghouse—Thirty-six employes of the Westinghouse Electric & Mfg. Co., East Pittsburgh works, have received special recognition in the past six months for their more than 780 suggestions to improve

How strong is a 400-lb. Tobin Bronze weld? How quickly can it be made?

The story of the repair welding of this 15-ton roll housing reveals the answers to these important questions...



LAST March 8, this huge housing on a 33" rolling mill cracked resoundingly and thundered to the floor. Production orders were heavy on this particular mill and a replacement could not have been made for eight or nine weeks. To save time, two temporary repair-welds with Tobin Bronze were tried. Welders, working steadily in two shifts, used 400 lbs. of Tobin Bronze 3/8" welding rods for each weld; consumed only nine days to complete the work. On March 17 the housing was back in place ready to go...So much for how quickly welds of Tobin Bronze can be made.

Production was resumed, the plant superintendent hoping that the repaired housing would stand up under terrific operating pressures of the rolls until a new casting could be obtained. Six months later that mill was still rolling its quota of metal. *What's more,* during this period, a roll neck broke in the housing. The abnormal stress that brought about the fracture in the heavy roll was absorbed by the welded housing with no sign of failure. Such service is proof positive of the high strength of properly made Tobin Bronze welds in cast iron.

Tobin Bronze welding rods are stocked by all leading supply houses. Make sure that when you buy Tobin Bronze it bears the trade-mark "Tobin Bronze—Reg. U. S. Pat. Off."—only then you will be getting the genuine. 40115

ANACONDA

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Company

their company's operations and productions. Of these men, 18 have received awards of $25 or more during the period for outstanding suggestions and the others have received additional awards for contributing 35 or more suggestions since inauguration of the "Suggestion System" in 1910.

Awards, in general, are given for suggestions looking toward better working conditions, suggestions for greater safety and accident prevention, and suggestions involving cost reduction. During the past 29 years nearly 60,000 suggestions have been made by employes in the company's various divisions, approximately 35% of which have been accepted by the suggestion committee.

A.W.S. Activities

St. Louis Section A.W.S.—The "Welding of Stainless Steel' was the subject of an interesting paper by **A. J. Moses** of Combustion Engineering Co., Chattanooga, Tenn., at the February 9th meeting.

» «

Northwest Section, A.W.S.—F. G. Flocke, of the Development and Research Division of The International Nickel Co., Inc., presented a talk on "Fabrication of Monel, Nickel and Inconel in Solid and Clad Plate Construction" before the Northwest Section, A.W.S. meeting held at the Minnesota Union, University of Minnesota, Minneapolis, January 16.

» «

Milwaukee Section A.W.S.—At the regular meeting of January 26th, **George T. Horton,** national president of the American Welding Society, presented an illustrated talk detailing the welding of storage tanks such as constructed by Chicago Bridge & Iron Co., of which he is president. Milwaukee Section meetings are held at the City Club, 756 North Milwaukee St.

» «

Oklahoma City Section A.W.S.—E. W. P. Smith, consulting engineer of the Lincoln Electric Co., discussed the perplexing subject of expansion and contraction at the regular meeting January 5th, held at the Biltmore Hotel. A motion picture "Evolution of the Oil Industry" depicted the historical development of this huge industry. This was a Bureau of Mines picture made in cooperation with the Sinclair Refining Co.

» «

Detroit Section A.W.S.—At the regular meeting held February 9th in the Colonial Room, Detroit-Leland Hotel, **D. H. Corey,** welding engineer, The Detroit Edison Co., spoke on the subject "Welded Piping—Codes and Practices."

» «

New York Section A.W.S.—"Heat Treatment with the Oxy-Acetylene Flame" was the subject of an interesting talk by **John J. Crowe** at the February 13th meeting held in the Engineering Societies Bldg., 33 W. 39th St., New York City. Mr. Crowe is manager of the Apparatus Research and Development Dept. of Air Reduction Sales Co. A motion picture story of the flame-hardening process was also included on the program.

» «

Cleveland Section A.W.S.—At the regular meeting held February 14th at the Cleveland Club, **George F. Wolfe** of the Dravo Corp., spoke on the subject "Assembly Plant for Mass Production of Welded Barges and Other Structures."

» «

Philadelphia Section A.W.S.—At the regular meeting February 19th, held at the Engineer's Club, the subject of "Flame Cleaning" was presented by a representative of Air Reduction Sales Co., and the subject of welding copper-base alloys was discussed by a representative of the American Brass Co.

» «

Chicago Section A. W. S.—At the February 16th meeting, **W. B. Browning,** process service engineer, **The Linde Air Products Co.,** spoke on the subject, "The Widening Scope of the Oxy-Acetylene Process." In this illustrated talk, Mr. Browning touched on some of the new

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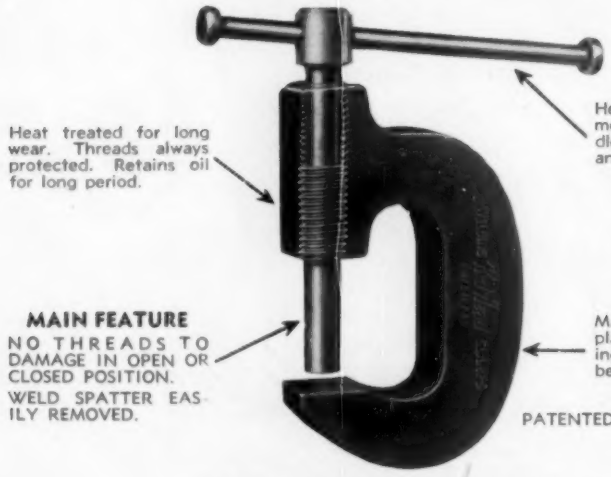
Heat treated for long wear. Threads always protected. Retains oil for long period.
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MAIN FEATURE
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WELD SPATTER EASILY REMOVED.
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and unusual applications and developments in welding, cutting, heating, flame-conditioning and other uses of oxygen and acetylene. Chicago Section meetings are held at the Chicago Lighting Institute Auditorium, 36th floor, 20 N. Wacker Drive.

Construction

H. C. Price Co. of Bartlesville, Okla., have been awarded the contracts for electric arc welding and have started construction on the following pipelines:

For Sohio Pipe Line Co.—250 Miles of 12-In. from Stoy, Ill., to Lima, Ohio—General Contractors, Sheehan Pipe Line Construction Co. and Truman-Smith Construction Co.

For Panhandle Eastern Pipe Line Co.—140 Miles of 22-In. and 24-In. Loops in Kansas, Missouri and Illinois—General Contractors, T. R. Jones, Inc. and I. C. Little.

For Shell Petroleum Corp.—10 Miles of 6-In. and 8-In. in Illinois—General Contractor, I. C. Little.

Recent Patents

Spot Welding Tool

2,183,908. **Walter Gladitz,** Augsburg, Germany. Filed March 6, 1937. Issued Dec. 19, 1939. A manual spot welding tool consisting of a pair of tongs comprising two jaws and handles. Electrode holders are detachably mounted on these jaws and insulated from the jaws. A third handle is mounted on one of the jaw handles and this third handle has a spring element, which upon movement of the jaw handles, compresses and permits electrical contact to be made after a predetermined pressure has been reached. All three handles are mounted on a common pivot. The welding current is terminated at a predetermined current intensity.

» «

Contact Making Mechanism

2,184,335. **Verni J. Chapman,** Schenectady, N. Y., assigned to General Electric Co., New York. Filed Sept. 16, 1938. Issued Dec. 26, 1939. In automatic arc welding machines, the electrode is usually fed from a spool so that a considerable length can be provided. This is advantageous whenever continuous welding is to be performed. Such an electrode is connected to the welding circuit through brushes or contact members which engage the electrode as it passes through the brush mechanism. In this type of apparatus, it is advantageous to provide simple and efficient means which will compensate for wear of the brushes and provide between the brushes and the electrode a proper pressure which can be readily adjusted for different sizes of electrodes. The patented contact making unit has a frame and contact blocks pivotally arranged with respect to the frame. Electrode engaging brushes are supported by the contact blocks. Resilient biasing means hold the brushes in frictional engagement with the electrode.

» «

Welding Tip

2,184,479. **Matthew J. Wall,** Jersey City, and **Marvin R. Scott,** Elizabeth, N. J., assigned to Oxweld Acetylene Co., West Virginia. Filed Jan. 29, 1937. Issued Dec. 26, 1939. Rapid welding may be obtained by means of the multi-jet welding tip of this patent. The welding flame comprises a main welding jet and two flanking jets, one on each side of the main jet. With the use of two small individual auxiliary welding jets so located, the distribution of flame intensity is improved, thereby bringing to fusion temperature the entire beveled V-joint from top to bottom at the point of welding. With such a tip, it also becomes unnecessary to move the tip from side to side in order to obtain a proper weld. The tip may be given the straight line movement which is required for high-speed welding. The tip also carries suitable preheating jets.

» «

Welding Nozzle

2,184,499. **Frank C. Hutchison,** Kansas City, Mo., assigned to Union Carbide and Carbon Corp., New York. Filed May 25, 1935. Issued Dec. 26, 1939. This patent relates to a welding head made as a one-piece body and having an axially extending bore terminating in a single main

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Experienced welders everywhere prefer these TITAN bronze welding alloys—doubly deoxidized to protect against formation of gases and oxides:

Penn Bronze—is a general purpose rod. It is low melting (1620° F.) and tins easily and uniformly on galvanized, malleable or wrought iron as well as steel, brass, bronze and any other non-leaded metal with a melting point above 1850° F. It makes tough high-strength welds of high ductility, immune to strain hardening and with great abrasion and corrosion resistance.

Titan Manganese Bronze—is used where both hard and tough welds are desired. Although this is a general purpose rod, it is especially recommended for cast iron. It is free flowing and gives extremely dense, non-porous welds.

Titan Bronze—is a tin bronze with uses and characteristics similar to the manganese alloy; penetrates seams and crevices readily.

Samples of these doubly-deoxidized rods gladly furnished for trial in your own plant. Send for descriptive literature.

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welding jet discharge orifice. A pair of parallel gas outlet passages communicate with the bore and extend through the wall of the head at an angle acute with respect to the axis of the bore. The passages are provided with preheating jet orifices disposed at a substantial distance behind the main orifice.

» «

Welding Rod

2,184,518. **John Trimble Each,** Crangord, and **Thomas J. Wood,** Nutley, N. J., assigned to The International Nickel Co., Inc., New York. Filed July 27, 1938. Issued Dec. 26, 1939. A satisfactory dense, gas-free, nickel-chromium cast-iron overlay can be deposited upon iron and steel articles by means of the welding rod of this patent. The deposit adheres tenaciously to the base, and has an exceptionally high Brinell hardness. The rod comprises in approximate proportions 2.0 to 4.0% carbon; 0.25 to 2.0% silicon; 2.0 to 5.0% nickel; 0.25 to 3.0% chromium; 0.10 to 1.5% manganese; sulphur and phosphorus not in excess of 0.20% and 0.30% respectively; 0.5% of a deoxidizer selected from the group of aluminum and calcium-lithium; 0.5% boron; and the balance essentially iron. The resulting weld is not pitted and is stated to have a good clean appearance.

» «

Stress Relief Treatment

2,184,534. **Harry B. Smith,** Glen Rock, and **George A. Dolan,** Hohokus, N. J. Filed Nov. 26, 1937. Issued Dec. 26, 1939. A process of butt-welding metallic members together which consists in applying windings around the adjacent parts of the members, passing alternating current through the windings to induce preheating currents in the parts, then arc-welding the joint between the members, while the windings are still in place, and when the welding is completed, immediately applying current again to the windings and controlling it so as to normalize the weld. This treatment relieves internal stresses caused by heat localization. The method is stated to be of particular value in the welding of pipe ends.

» «

Filling Material

2,186,115 and 2,186,117. **Arthur R. Lytle,** Niagara Falls, N. Y., assigned to Oxweld Acetylene Co., West Virginia. Filed May 7, 1938. Issued Jan. 9, 1940. These patents point out that while ordinary brass of the type containing about 60% copper and 40% zinc is an inexpensive welding material, the uses are restricted in some fields by the relatively high melting point of the brass and by its property of emitting zinc fumes when melted. According to the inventor's discovery, these disadvantages are overcome by including 1 to 6% of cadmium and 0.01 to 0.5% of silicon in a material containing 62 to 47% of copper and the remainder substantially all zinc, the zinc content being at least 20%. Silver may be added in an amount up to 10%. Preferably the cadmium content is between 2 and 4%, and the silver, when present, is between 2 and 6%. Small amounts of other and incidental materials, such as tin, iron, and manganese may be added up to 2%. This composition is used in the form of welding rods in the brazing of malleable iron and other metals.

» «

Welding Alloy

2,186,116. **Arthur R. Lytle,** Niagara Falls, N. Y., assigned to Oxweld Acetylene Co., West Virginia. Filed Sept. 30, 1938. Issued Jan. 9, 1940. In the oxy-acetylene welding of copper-bearing alloys of the lead-containing bronze type, it is necessary to employ a strongly oxidizing flame. It is also necessary to perform the welding operation slowly and carefully to ensure weld metal free from porosity. It is desirable, obviously, to be able to weld at high rates, for example, at the rate of 50 to 60 lbs. of weld metal per hour. Such a rate requires the maintenance of a large and deep puddle of weld metal, and since an oxidizing flame must be used, the molten metal is subjected to severe oxidation. As a result of such oxidation, an undesirable slag is formed on the surface of the puddle and within the body of the puddle. This slag, the inventor has found, can be made to rise to the surface of the puddle by increasing the zinc content of the bronze and by controlling other ingredients in the metal. A suitable welding composition is disclosed as containing 8 to 18% lead; 5 to 12% tin; 8 to 15% zinc; 0.05 to 0.5% silicon, and the remainder substantially all copper. The slag produced by this weld metal is fusible, floats readily, and responds to the fluxing action of normal fluxes.

» «

Electrode Holder

2,186,158. **Lloyd W. Weeks,** Inglewood, Calif., assigned in part to Charles F. Briscoe and Fred Nelson, Los Angeles, Calif. Filed May 24, 1938. Issued Jan. 9, 1940. An electrode holder comprising a hollow handle made of suitable insulating material, and a pair of jaws extending forwardly of the handle and adapted to be spread by relative movement of the handle axis laterally. Within the handle and concealed from exposure to flying metal, there is a coil spring for closing the jaws.

» «

Welding Support

2,186,708. **Charles A. Richardson,** Pittsburgh, Pa., assigned to United Engineering & Foundry Co., Pittsburgh, Pa. Filed July 22, 1936. Issued Jan. 9, 1940. There is described a support for holding parts to be welded in desired positions. The support is adapted to place the members at equal angles with the horizontal. Such positioning is desirable in welding two members which form an angle with each other, inasmuch as the weld material flows more uniformly over both members and produces a neater and stronger joint. More specifically, in joining two plates at right angles to each other, it is advisable to place each plate at an angle of 45 deg. to the horizontal and with the line of joint horizontal, so that in welding the filler material can be placed in the groove uniformly. The support is of special utility in welding large sections, such as railroad car truck frames.

» «

Non-Corroding Weld

2,187,525. **Paul Schafmeister** and **Eduard Houdremont,** Essen, Germany, assigned to Krupp Nirosta Co., New York. Filed Sept. 19, 1929. Issued Jan. 16, 1940. An article of welded construction for use in the chemical and metallurgical fields which, without being annealed after welding, stubbornly resists intergranular corrosion within the zone tempered by the

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NEW! TITE-KOTE WELDING ELECTRODE
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Welds made with this new electrode possess the same ductility and toughness possessed by deposits made with MANGANAL bare electrodes.

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welding operation when subjected to corroding media. The weld material includes vanadium which has the effect of binding to itself almost the entire carbon content. This action leaves no free carbon and avoids a brittle condition when the metal is heated to high temperatures.

» «

Welder's Goggles

2,187,542. **Ole E. Hagen,** Chicago, Ill. Filed Oct. 10, 1938. Issued Jan. 16, 1940. To permit a welder to wear ordinary correction glasses during the welding operation, the inventor has devised a goggle pivotally mounted on a head band, the goggle fitting over the correction glasses. Suitable locking elements hold the goggle in place.

Trade Literature

The Welding Engineer's Pocket Book—Chemical Publishing Co., Inc., 148 Lafayette St., New York City, has just published **The Welding Engineer's Pocket Book,** a small pocket size data book to help the man in the welding shop. The information is highly condensed and is entirely based on English practice. We presume, from the introduction, that the book was prepared by welding authorities in England. Studying the Table of Contents, it is apparent that both metallic arc and carbon arc welding are covered in rather complete detail. Various systems of resistance welding are also described. Oxy-Acetylene welding is covered in a single chapter. The welding of various metals is covered in considerable detail, including a discussion of low-temperature welding of cast iron. The book totals 240 pages and sells for $1.50 postpaid.

» «

For Glare Protection—Furnace and foundry operations and the increasing use of arc and gas welding in industry present a complex problem in eye protection involving the safeguarding of the eye not only from the glare of visible light but also from dangerous infra-red and ultra-violet rays. To choose the proper glare protection glass, American Optical Co., Southbridge, Mass., has prepared a small table which summarizes test data on the density, percentage of transmission of visible light, and the adsorption of the dangerous ultra-violet and infra-red rays of Noviweld and Calobar glass developed specifically for industrial use.

» «

1940 Edition of Standard Metal Directory
This is the Eighth Edition of the **Standard Metal Directory,** the previous one having been published in 1936. The old edition has been completely revised and all information brought up-to-date. The 1940 edition contains over 600 pages. The directory is divided into four special sections embracing: Iron and Steel Plants; Ferrous and Non-Ferrous Metal Foundries; Metal Rolling Mills; Smelters and Refiners of Non-Ferrous Metals.

In these lists will be found more than 11,000 detailed reports on steel mills, ferrous and non-ferrous metal foundries, metal smelters, metal rolling mills, and non-ferrous metal plants in the United States and Canada, arranged geographically and alphabetically. These reports give the name of the company, its capitalization, when organized, the location of its plants, address of main office, company officers, purchasing agents, sales manager, plant equipment, number of employees, products manufactured, annual productive capacity and type of raw and semi-finished materials consumed.
The **Standard Metal Directory** is published by the Atlas Publishing Co., 150 Lafayette St., New York City. The directory sells for $10.00 a copy.

» «

Westinghouse Heater Catalog—New and improved electric heating units and controls, designed to meet specific industrial applications for heating liquids, solids, and air, are announced in a new 38-page illustrated catalog issued by Westinghouse Electric & Mfg. Co., Mansfield, Ohio. Strip heaters, cartridge heaters, corox immersion heaters, and air heaters, are featured in successive sections of the catalog. Copies of Catalog 28-000 may be secured from the Heating Division, Westinghouse Electric & Mfg. Co., Mansfield, Ohio.

BRONZE WELDING RODS "192" LOW FUMING

Bridgeport's "192" Low Fuming Bronze Rods* will hold fuming to an extremely low level on your gas jobs. Check these other first-rate advantages of Bridgeport's "192" for both your general repair work and building up surfaces:

Sound, Strong, Tough Deposits
Free Flow
Low Melting Point
Very Good Tinning Action
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*Manufactured under U. S. Patents RE 17,613 and 1,525,068

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For Sale—Over 50 used, rebuilt arc welders; generators only; electric or engine drive; 50 amp. Hanson, $60; 75 amp. Lincoln, $90; 100 amp. Lincoln, $110; 150 amp. $140; 200 amp. combination electric and engine drive. Also 300 and 400 amp. units. 6000 ft. used rubber-covered super-flexible cable No. 2, 16c; No. 1, 19c; 1/0, 21c; 2/0, 25c. Also 3/0 and 4/0. Metal spray gun, $75. Pierce Governor, like new, $18. Address F-1, The Welding Engineer.

Fly-Ball Governors—Adapted to all makes of auto engines; belt driven, flat or V. Price $6.50 prepaid; ball bearing $2.00 additional. Satisfaction guaranteed. In ordering state style of belt. Wm. Alber, Beatrice, Nebr.

For Sale—Welding and Machine Shop. 20 yrs. old. Location close to business section, city of 50,000. Low rent. First-class money-making business. Write to owner, 1040 South S.E., Warren, Ohio.

Bargains—Demonstrator Arc Welders. Gasoline and electric drive. 30 days' trial. Easy terms if desired. Write Hobart Welder Exchange, Box U-2401, Troy, Ohio.

For Sale—Acetylene Welding Equipment, $39.95 to $73.75. Easy Payment Plan. Superior Oxy-Acetylene Machine Co., Hamilton, Ohio.

HELP WANTED

Salesmen—Supply Jobbers—Something New in Gloves—Made of heat-resistant non-burn leather with sewed out-seams and **in addition** seams are wire stapled. Positively cannot rip or burn out at the seam. Welders, hot iron and steel workers everywhere will want them. Supply jobbers will want to add them to their lines. Write for our attractive proposition to introduce this new glove to the trade. M. J. Paul, Berlin, Wis.

POSITION WANTED

Gas and Arc Welder—Desires position as helper to gain experience. Welding school graduate. Also machinist. Go anywhere. Single. Age 25. Leonard Strom, Parshall, N. Dak.

Arc Welder—1 year experience. Some experience in airplane welding. Can read blue prints. Free to travel. A Urbanowich, 301 Wabash Ave., Wichita, Kans.

Combination Welder—3 years experience in steel mill as welder and cutter. Familiar with pipe welding, hard surfacing, brazing and cast-iron welding. Single. Age 27. Herbert Olson, 7842 Stewart Ave., Chicago, Ill.

Welder's Helper—Wishes work with engineer. References. Will go anywhere. Now employed. Address F-2, The Welding Engineer.

Hard-Facing Specialist—3 years experience in steel research. 4 years in research, production and sales, manufacturer of hard-facing electrodes. Salaried position desired. Go anywhere. Young man, married. Address F-3, The Welding Engineer.

Combination Welder, 25 years old. Technical Institute graduate. Seeking experience. Salary secondary. Excellent references. Address Herman Rappaport, 8015 Bay Parkway, Brooklyn, N. Y.

WANTED TO BUY

Wanted to Buy—Live welding equipment and supply dealer is interested in buying 50,000 ft. of various size welding cable. Manufacturers requested furnish details and prices. Address F-4, The Welding Engineer.

Wanted to Buy—National supply and equipment dealer has big demand for used arc welders and will buy or offer high trade-in. Can use 100 units immediately. Write fully. Address F-5, The Welding Engineer.

MISCELLANEOUS

Reward—Our ad of last month located two of the "lost" machines; one in Elmira and one in Washington. However, we are still missing the machine which was delivered to Jamestown, N. Y., and then taken to Pennsylvania. Serial Number SB15-120665, 500-amp., 220-volt DC driven Dualarc motor-generator set. Will pay $25 reward for any information as to above, and $50 for information that locates the apparatus. Address C. J. Holslag, Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J.

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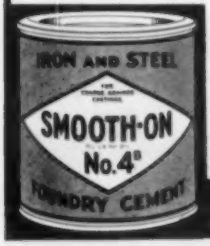

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THOUSANDS OF WELDING SHOPS ARE MAKING ADDITIONAL PROFITS IN THIS NEW FIELD

Is your shop? Prepare your shop during the winter months for more profits next year.

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Canadian Patents 365,296 and 369,723

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Write for new catalog now

WIESE PLOW WELDING COMPANY, PERRY, IOWA

Originally New Process Plow Welding Co.

WELDERS Your Engine Driven Welder will provide correct heat at the arc if the motor is equipped with a sensitive PIERCE GOVERNOR. ASK YOUR WHOLESALER

THE PIERCE GOVERNOR CO., Anderson, Indiana, U. S. A.